OHIO BRASS MANAGEMENT REPORT

# What technology? Let's start with this list

**BY ROGER A. BLACK**
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY

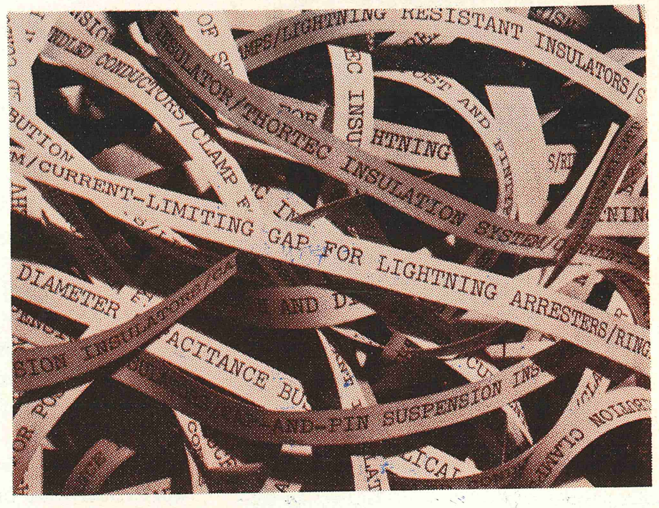
Before you ask the question, we have asked it of ourselves:

"Since an argument for buying domestic electrical equipment states that American manufacturers lead in technology, to what specific accomplishments can O-B point to support the argument?"

For an answer — two lists of answers, in fact — we went to our engineers who have a reputation for objectivity, untainted by commercial considerations. To make the exercise more interesting, we asked for independent replies from engineering groups at two different O-B plants.

**THEY LISTED** what they considered to be O-B's outstanding contributions to the electric power industry. The two lists had six items in common, including the modern cap-and-pin suspension insulator which opened the way for bulk transmission of electric power.

**ALSO ON BOTH** lists was the newest O-B development, the Thortec insulation system with special features to combat lightning and contamination outages on distribution lines. Another item high on both lists was the current-limiting gap for lightning arresters . . . hardly a surprise, since this development made possible lower BIL's in transformers and opened the way for 500-kv and 765-kv systems that had station components of manageable sizes.




**RINGLESS,** corona-free hardware for EHV bundled conductors and the clamp for post and pintype insulators also appeared, as did the lightweight, reduced-diameter, capacitance bushing—the latter a corollary development to the reduced BIL in transformers. Helical stress cones for potheads, controlled curvature of strain-clamp seats, corrosion intercepting sleeve, ball-and-socket hardware, aluminum transmission and distribution clamps, lightning-resistant insulators, and the sanded surface for suspension insulators were other familiar items.

**POSSIBLY** you have your own candidates for the list, but it is long enough now to demonstrate that O-B has made significant contributions to electrical technology . . . contributions that have been possible only because of your continued purchases of O-B products.

774-H

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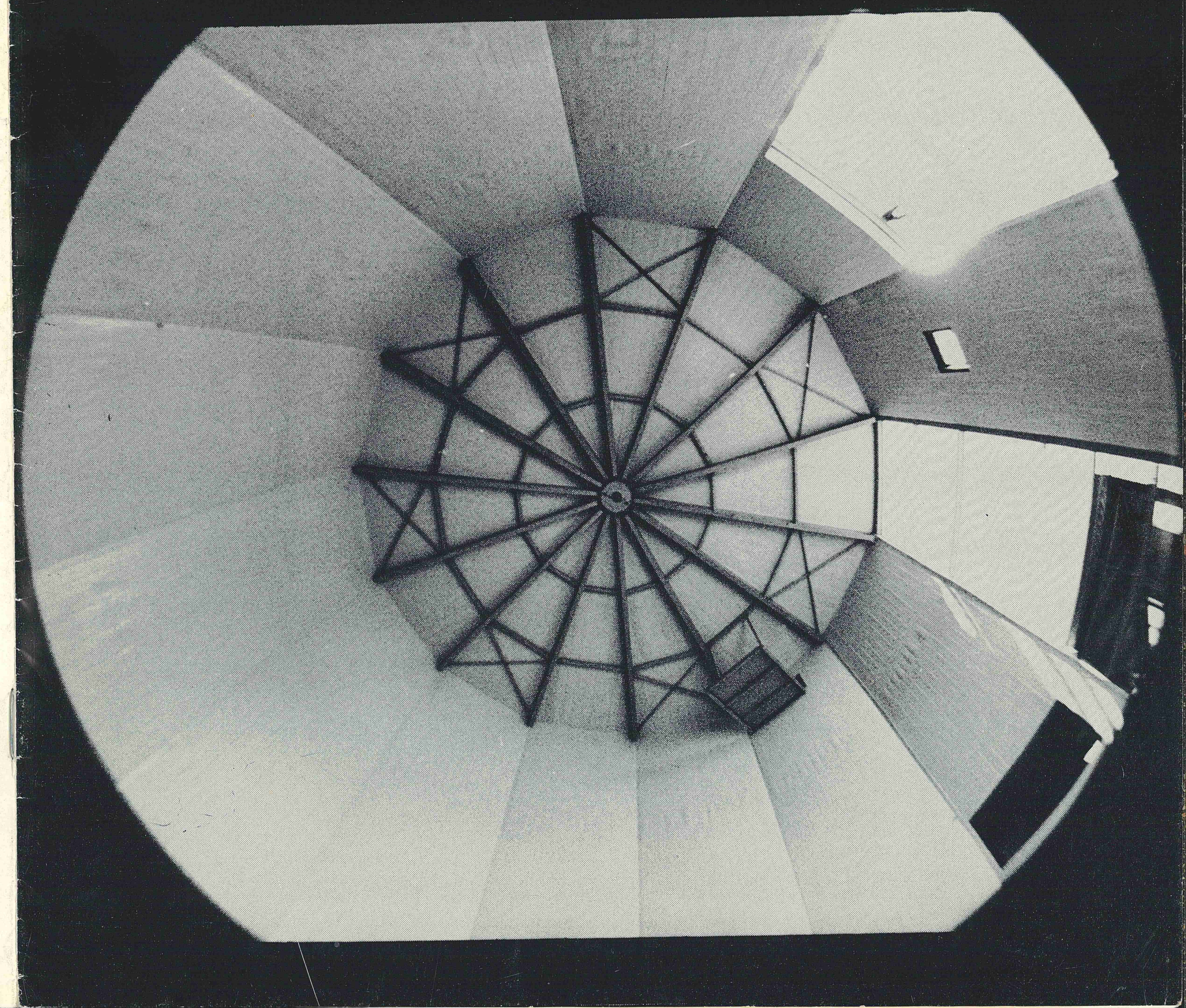
# Hi-Tension News

JULY 1968

RECEIVED JUL 8 1968 NEUHOF

RECEIVED JUL 11 1968 WHEELER



# they're already starting to refer to "MY OFFICE"

Early in May when this was being written, construction was approaching completion at O-B's Frank B. Black Research Center. Equipment was being moved in, miles of wire strung, controls being installed. The laboratory was beginning to look like something. Some of the people were already using the expression, "my office," to describe a set of partitions. By the time you read this, many of these offices will be occupied, and some of the equipment operating.

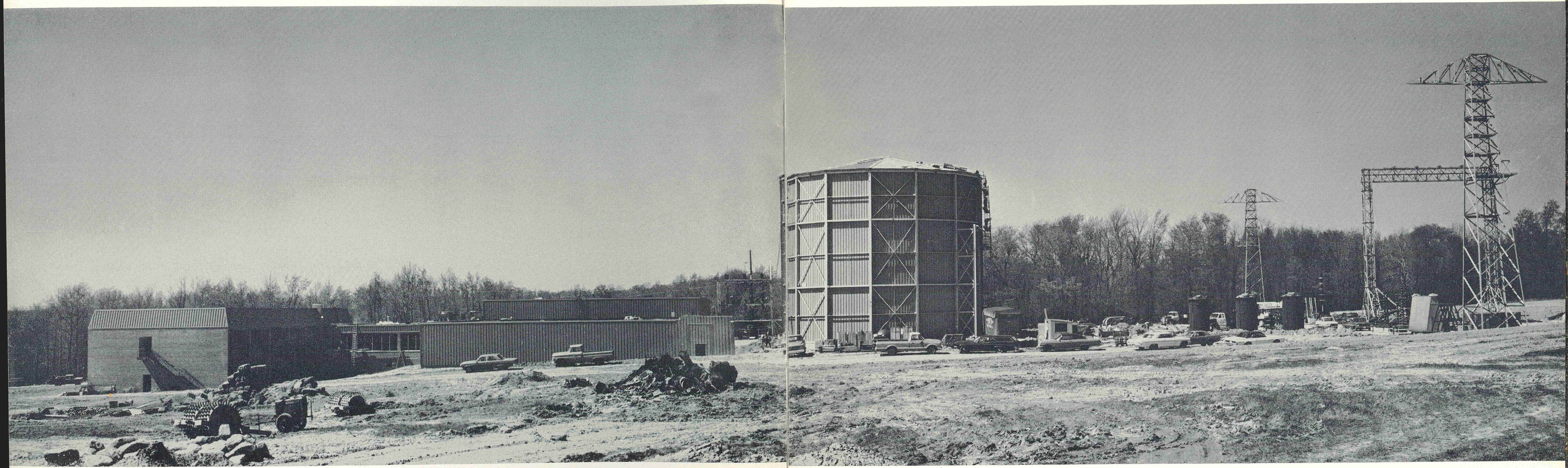
Rapidly taking shape is one of the showplaces of the new laboratory. Fronting on a long hallway are five large-size test cells, each containing a piece of major equipment, such as a 220 - kilojoule, 4,000 - microfarad test apparatus, a 150,000 - ampere surge generator, and other devices for long-duration and duty-cycle testing. Also included is a source of low-voltage high-power d c.

Each piece of equipment will be controlled by a miniaturized portable station. On the outside of each cell, adjacent to an observation window, provisions are made to plug in any number of these portable control panels at that location. In this way, two or more pieces of test apparatus can be supervised from a single point and operated simultaneously. An elaborate bus system augments this arrangement by permitting interconnection and combination of any equipment in the area.

Through this system of universal combination of facilities and centralized control of the resulting test circuit, complex electrical studies can be conducted under ideal technical conditions.

With the picturesque rural location of the laboratory, it would be expected that a few of the human factors have also been considered. Glare- and heat-resisting glass is used extensively throughout the structure. Between the main building and indoor laboratory is a large court fronting on a window-lined hallway between the two structures. Some of our green-thumbed technicians have ambitious plans for turning this space into an attractive garden spot.

**Pouring the concrete floor** of the controlled atmosphere test chamber. Referring to the 150-degree-angle fish eye picture on the cover, the two openings at the lower right are observation windows in the control room. On the upper right is a four-story sliding door for moving-in large test specimens. The platform at ceiling level will contain some of the large blower and fog equipment used in creating any desired atmospheric condition.

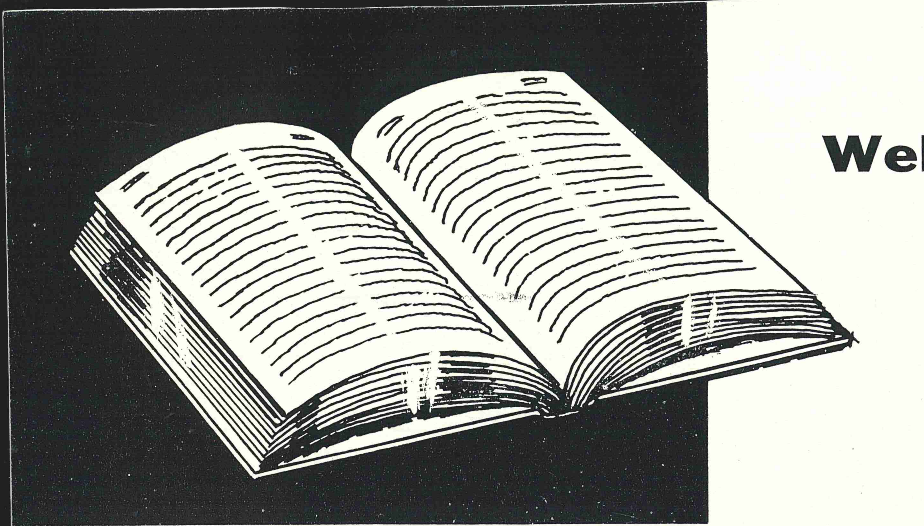


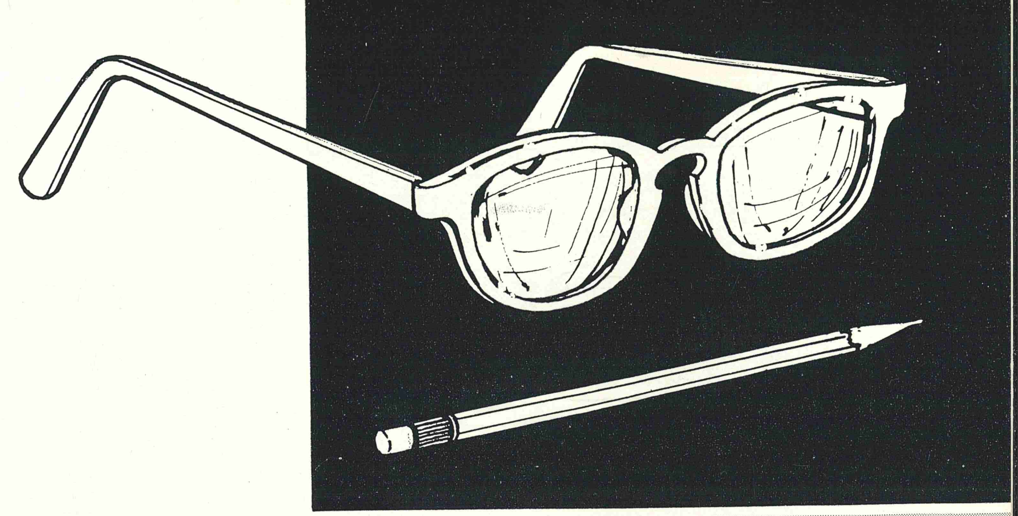
**General view of the laboratory** as construction nears completion. On the left is the office, including chemical, physical, and ceramic laboratories, drafting, and other services. At the center is the indoor electrical laboratory, looking at it from the low bay end. The high bay in the background will be used largely as a testing area. Dominating the scene is the controlled atmosphere test chamber 60 feet in diameter by 70 feet high. In the outdoor test yard, the three 750-kv a-c transformers have not yet been mounted on their elevated pedestal supports. The two strain towers, 400 feet apart, and the test portal are ready for use.

O-B Hi-Tension News
JULY 1968, Vol. 37, No. 7

**ON THE COVER** — In order to see the most of O-B's controlled atmosphere test chamber, a fish-eye lens was pointed upward toward the roof girders 70 feet above the floor.

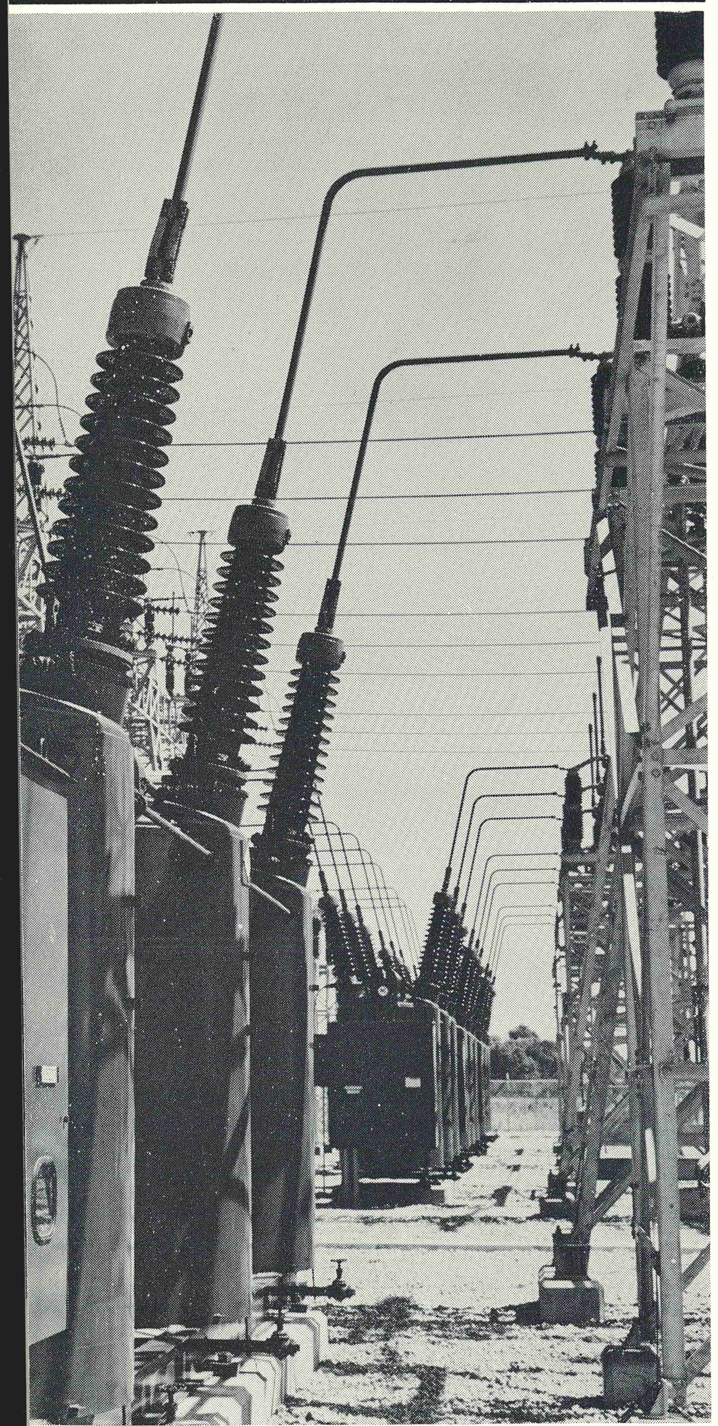
THE OHIO BRASS COMPANY
Mansfield, Ohio 44902





# Webster's new Collegiate Dictionary doesn't know about potheads . . .

## . . . and a bushing is defined as a detachable metal lining, used as a bearing for a shaft, axle, etc., . . . to reduce friction



230 kv O-B bushings installed in a major midwestern utility's system.

Potheads aren't mentioned at all. And bushings, to the electric utility industry, aren't exactly the way Webster describes them. But they're both important, even indispensable. The most critical element, in any power system which has underground lines, is probably the pothead, as far as design and manufacturing techniques are concerned. The tremendous electrical stresses generated at the point where the ground shield and underground cable terminate must be controlled solely by the pothead. Controlling these stresses requires skillful handling of the ground potential, insulating materials, and grading capacitance within the pothead — and demands manufacturing competence and design knowledge to consistently produce the most efficient cable termination equipment.

Ohio Brass is able to produce uniformly high-quality potheads, as well as bushings, partly because of the family relationships between the two. The foil-paper windings so important to proper stress cone construction in O-B potheads are constructed on the same machines, by the same people, as bushing cores. It requires a thorough familiarity with "paper technology" — the right kind of paper, how to wind it, how to dry it, how to impregnate it with oil — and these techniques have been perfected through years of experience in constructing oil-impregnated bushing dielectrics. O-B bushing insulation specialists are also, in many cases, O-B pothead insulation specialists, and the same standards of reliability and durability apply in both cases. Designed, produced and tested in virtually the same "nursery," O-B's high-performance cousins, the bushing and the pothead, share the same heritage and enjoy the same reputation for excellence.

Bushings and large lightning arresters have contributed still more toward the development of potheads at Ohio Brass. More than half a century of experience in fabricating the massive porcelain cones used in O-B bushings, and, more recently, the similar housings for large arresters, has led to a perfection of these techniques which puts Ohio Brass far ahead of its competition. Manufacture of such large porcelain pieces is a highly technical phase of ceramics. Their size and conformation make some of them very costly, and one of the responsibilities faced by the ceramic engineer is making sure they can be produced without expensive losses. It's obvious that manufacturing techniques have a very direct bearing on delivery and sales, under these conditions. It's an area where you must know exactly what you're doing, if there's to be a profit.

Not only must a pothead body be airtight, it must be able to contain oil without leaking. Again, this problem was previously solved by bushing developments; years of experience had shown the proper combination of materials and methods necessary to form a permanent leakproof seal. The men who had solved these problems with bushings applied their experience to pothead sealing, with excellent results. Today's O-B pothead seals securely — and remains sealed partly due to the application of skills gained in a similar and related field.

Certainly, pothead design poses new problems to the development engineer who has been associated with bushings at O-B. In the same context, though, many of the questions have already been answered, due to familiarity with associated products.

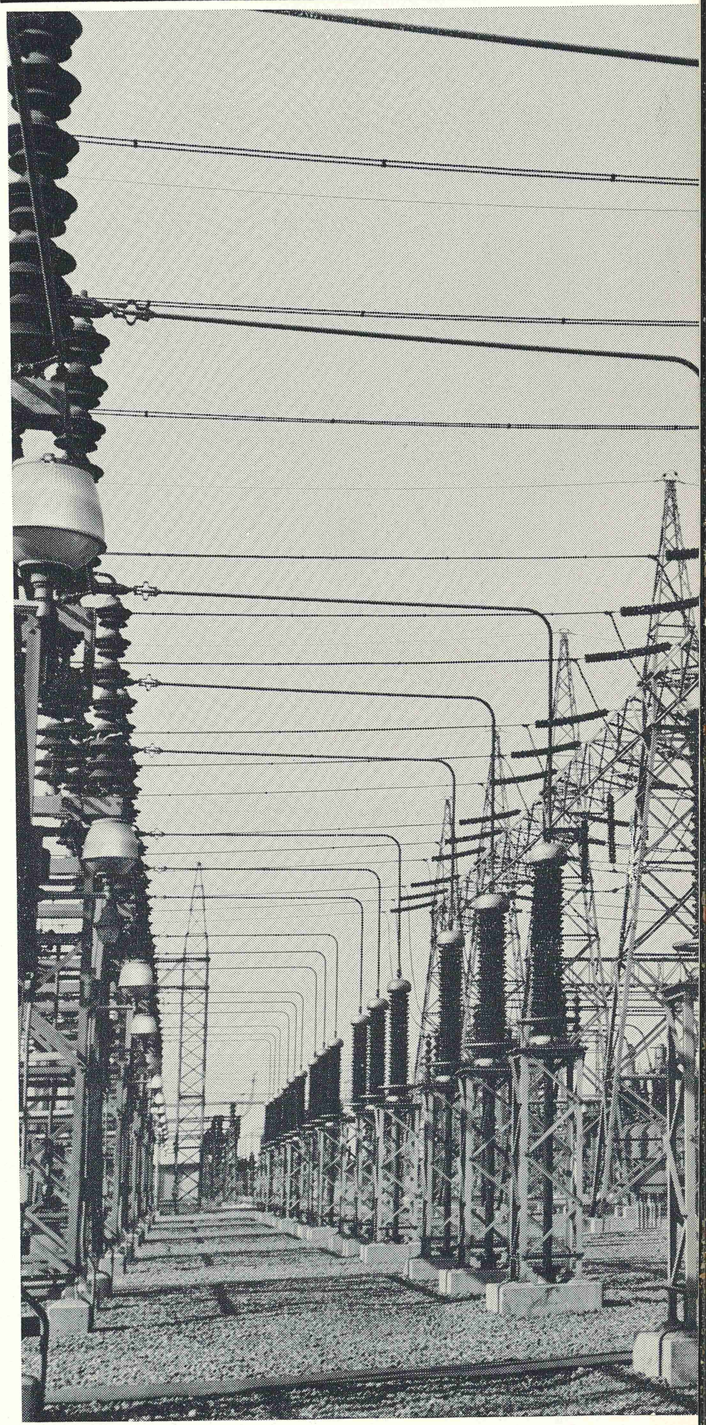
The development of Ohio Brass potheads has progressed rapidly, in the past few years. As early as 1932, O-B manufactured a "two-tube" pothead, with an internal pressure tube and an outer weather shed. These were available through 230 kv, but most production was in the 115-161 kv sizes. Over 115 kv, this type of pothead was bulky, and additionally the design was suitable for only high-pressure cable, not for low-pressure oil-filled cable.

While the "two-tube" pothead was a very good design for high-pressure cable — over 700 are in service — the amount of hand shaping of components, plus the difficult-to-produce porcelain shells then in use, led to discontinuation of the line in 1964. Capacitance grading, again an outgrowth of bushing technology, was the answer. Smaller, lighter potheads were possible, more automation could be used in manufacture, higher voltage ranges could be handled, and both high- and low-pressure oil-filled cables successfully terminated.

Capacitance grading principles proved in bushings have been used on all Ohio Brass potheads in recent years. 345 kv potheads were supplied for AEIC tests at Cornell University, and several manufacturers of paper insulated cable use O-B test potheads rated up to 800 kv to ground.

The special cable test project at Waltz Mill, Pennsylvania, planned by the Electric Research Council and under the direction of Westinghouse Electric Corporation and the Edison Electric Institute, will utilize 500 kv O-B potheads of a design similar to the highest-voltage test units the company has ever made. These potheads are currently under construction and will be in service later in 1969.

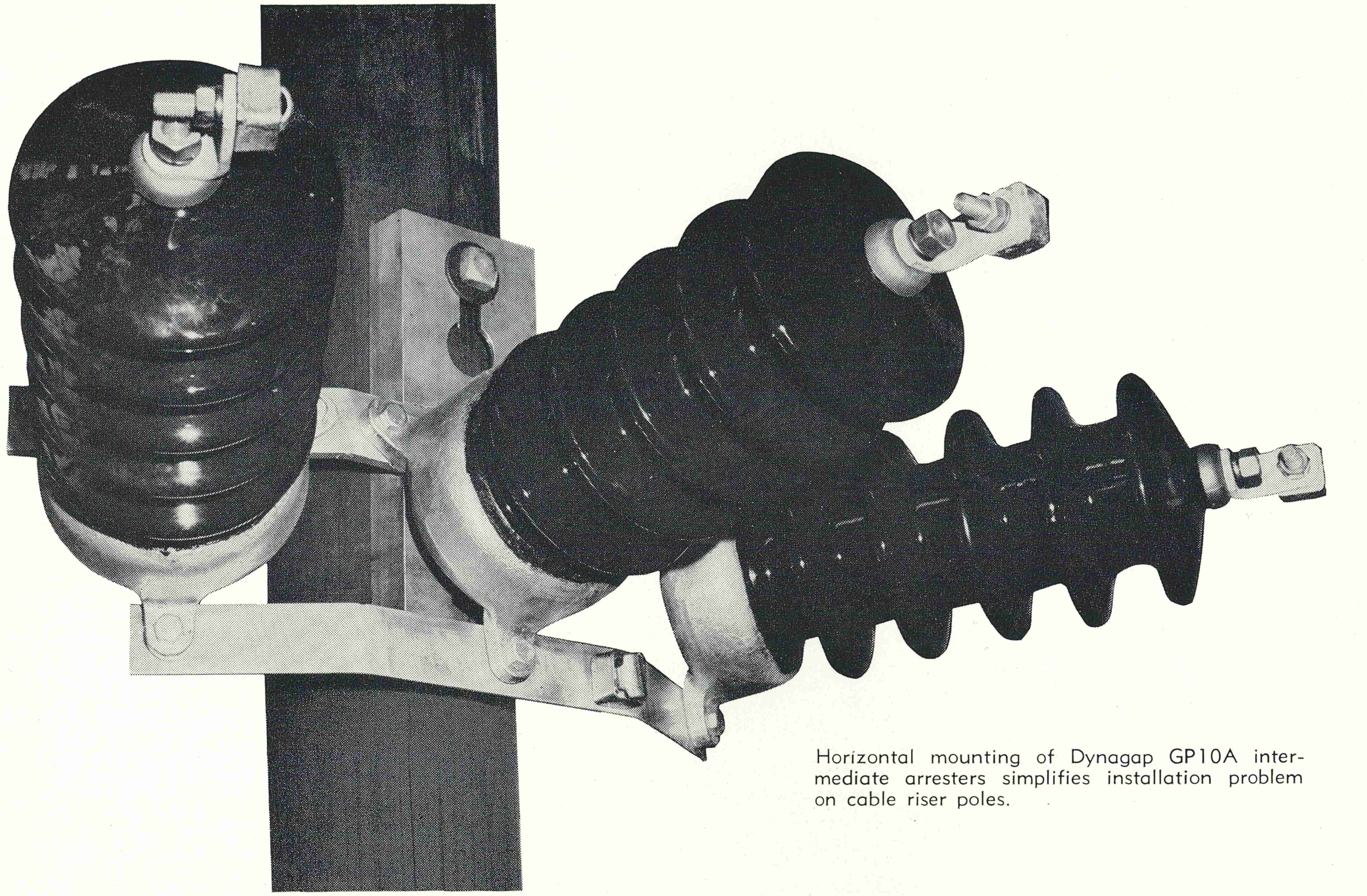
The interdependence in design between bushings and potheads continues at Ohio Brass. Certainly new methods and applications will benefit both equally as higher and higher voltages must be handled in order to keep pace with the nation's burgeoning electrical industry. And someday, when the ordinary citizen is finally made aware of the contributions to society made by electric utilities — and their suppliers — perhaps Mr. Webster will take note and recognize "potheads" and "bushings" on their own terms.



O-B potheads in a hydroelectric power station in Southwestern New York State.

## Superior characteristics of Dynagap GP's emphasize

# advantages of intermediate arresters for underground distribution protection



Horizontal mounting of Dynagap GP10A intermediate arresters simplifies installation problem on cable riser poles.

Preliminary efforts to establish appropriate protective recommendations for underground distribution circuits are responsible for the numerous surveys and analyses of present utility practices and preferences. Reports of arrester installations vary greatly from company to company and from one section of the country to another. Some of the sectional variations can be traced to and justified by the anticipated severity of electrical storms in specific areas, but the need exists for a more comprehensive evaluation of the factors involved in the application of arresters on underground distribution circuits.

A recent ELECTRICAL WORLD report (1) of trends in URD construction procedures showed that an overwhelming majority of utilities, 123 of a total of 128 respondents, mentioned the installation of arresters on cable riser poles. Only one additional aspect was revealed by the survey and that was nearly half of the reporting group also mentioned the installation of arresters at one or more points in the underground loop circuits.

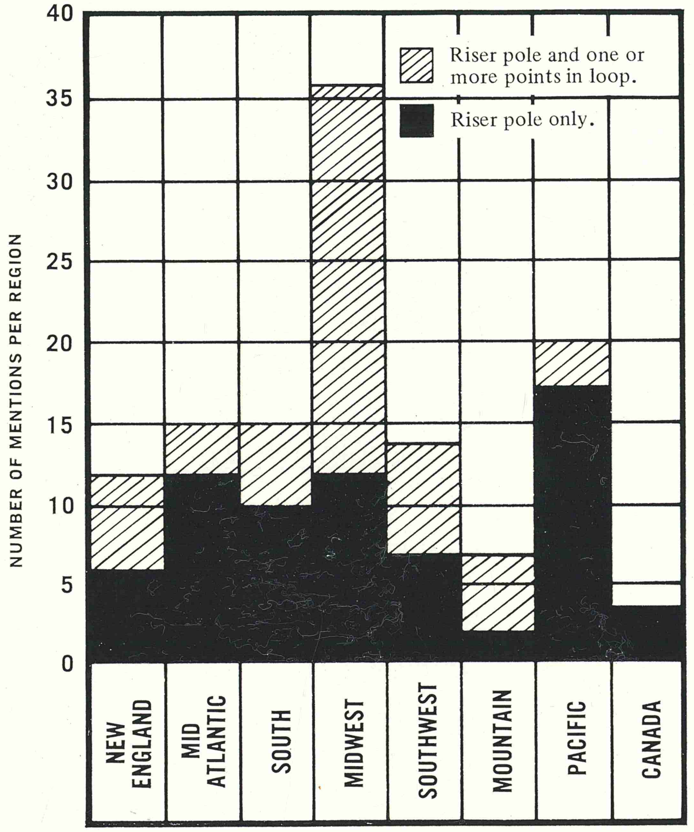
Results of the ELECTRICAL WORLD survey are interpreted in graphical form with replies divided into geographical areas. The Pacific Coast region leads in advocating riser pole arrester applications, while the Midwest and Mountain areas place the greatest emphasis on locating arresters at points throughout the loop circuits.

Protection of underground distribution circuits should not be assumed to be in the same category as overhead distribution. Any realistic appraisal of the investment in underground cables and equipment, the higher cost of possible outages, and the generally greater requirements for optimum service continuity provides the basis for reviewing the protective characteristics of arrester installations. Distribution arresters which provide entirely adequate overvoltage surge protection on overhead circuits may have limitations which become more pronounced when application is made to underground cables.

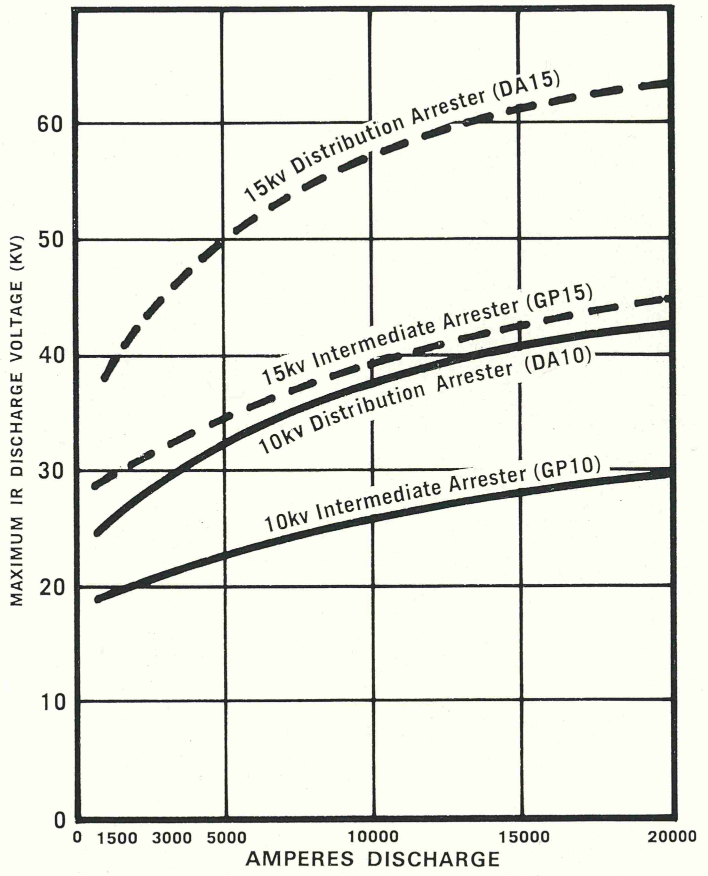
To compensate for these limitations, additional distribution arresters are often installed on the circuit with the result that riser pole arresters are supplemented in their protective function by similar arresters located as closely as possible to the protected equipment. The reasoning used to justify multiple arrester installations is that of providing backup protection against traveling waves, introduced into the loop circuit by high IR discharge voltages originating in the riser pole arresters, and reflected at points where substantial differences exist in surge impedances.

A substantial reduction in IR discharge voltages can be accomplished by installing intermediate-class arresters at the riser poles instead of the customary distribution type. Comparison of the cataloged values of IR discharge voltages of corresponding 10- and 15-kv distribution class (Type DA) and intermediate class (Type GP) arresters show this advantage graphically.

(1) ELECTRICAL WORLD Special Report "New Ideas in Underground Distribution," March 11, 1968.



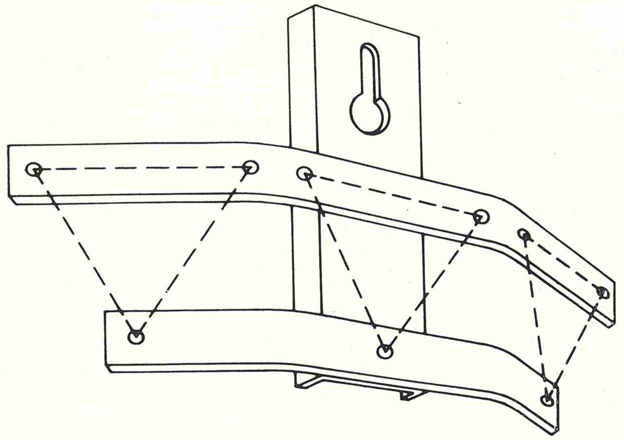

ELECTRICAL WORLD survey of underground distribution practices shows universal use of arresters on cable riser poles and extensive use at locations in the loop.



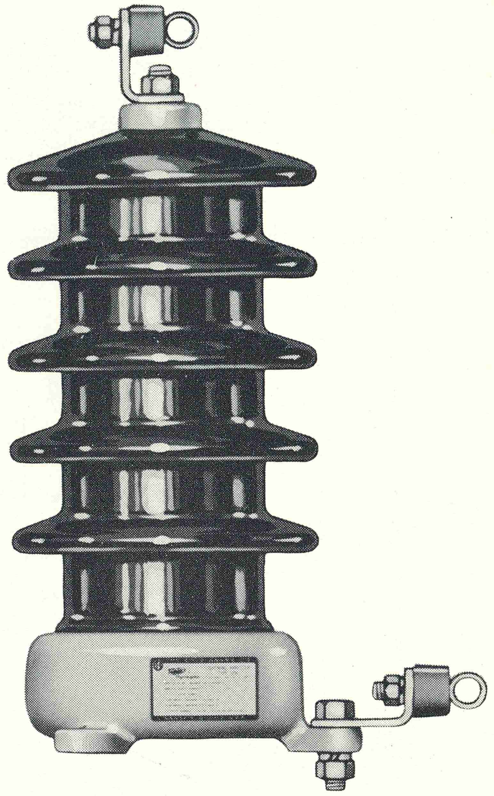

Comparison of IR discharge voltages of corresponding distribution and intermediate class arresters.

Intermediate arresters, particularly O-B's current-limiting gap GP's, provide other outstanding protective advantages. Sparkover is lower, immunity to the influence of exterior contamination is much greater, and durability in relation to long duration discharge currents typical of high capacitance circuits is of entirely different, higher order. The powerful current-limiting gap of the Dynagap GP arresters produces the fast, predictable interrupting action which distinguishes its superior performance and provides a level of protection and durability comparable to the most advanced station class arresters.

Installation of intermediate-class arresters at the cable riser pole diminishes the necessity of providing additional arresters at intermediate points in the underground loop. Supplementing the protective action of the riser pole arrester by using distribution arresters at each of the reflection points within the underground circuit adds an important degree of additional protection through the assurance that voltage



Special arrester mounting bracket developed for pole mounting of intermediate - class arresters.



O-B's Dynagap GP is the only intermediate arrester providing the superior protective performance associated with the current-limiting gap construction.

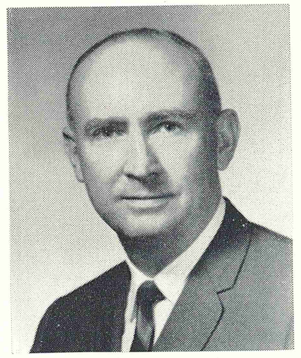
doubling of traveling waves will be chopped at the point of inception.

The cable riser pole has become the most common point of transition from overhead lines to underground cable. Configuration of the cable riser pole takes many forms, some being of the familiar crossarm construction, and others of the newer armless design. Where crossarms are used, intermediate - class arresters can be mounted vertically with relatively short leads to the connecting wires. Armless construction complicates the problem of locating and supporting not only the arresters, but the fuses, cutouts, and the pothead termination devices.

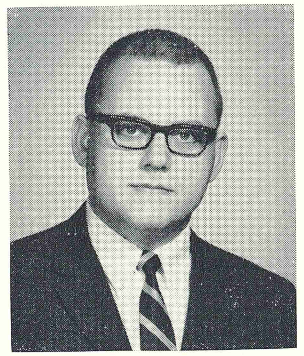
One of the more convenient solutions to this construction problem is available in suitable pole-mounting hardware, of which O-B's new GP intermediate-arrester mounting bracket is a typical example. This bracket is designed to position three GP arresters in a horizontal location with their line terminals readily accessible for connection in the service drop feeding the cable. Because the bracket provides a common ground for all three arresters, a single ground connection wire further simplifies installation.

Arrester installations made to date using the new mounting bracket have all used the porcelain top GP-A models. This housing design of the GP-A arresters eliminates the heavy malleable iron top casting of standard model GP arresters, thereby giving an improved appearance to the assembly and increasing clearance distances.

## Owens Becomes SE Exchange Executive; O-B Appoints MacNary To Atlanta Post



William B. Owens



Richard L. MacNary

William B. Owens, who has been Ohio Brass district manager in Atlanta since 1950, has been named executive director of the Southeastern Electric Exchange to succeed John W. Talley, on his retirement July 1.

Bill Owens has served O-B customers in the Southeastern states with great personal and technical competence. Our regret in losing his splendid representation is tempered by pride in the fact a distinguished group of electric utilities has chosen a man from O-B as its executive director.

Bill spent four years with Georgia Power Company before joining Ohio Brass. He served as an Army Ordnance officer during World War II and recently retired from the Reserve as a lieutenant colonel.

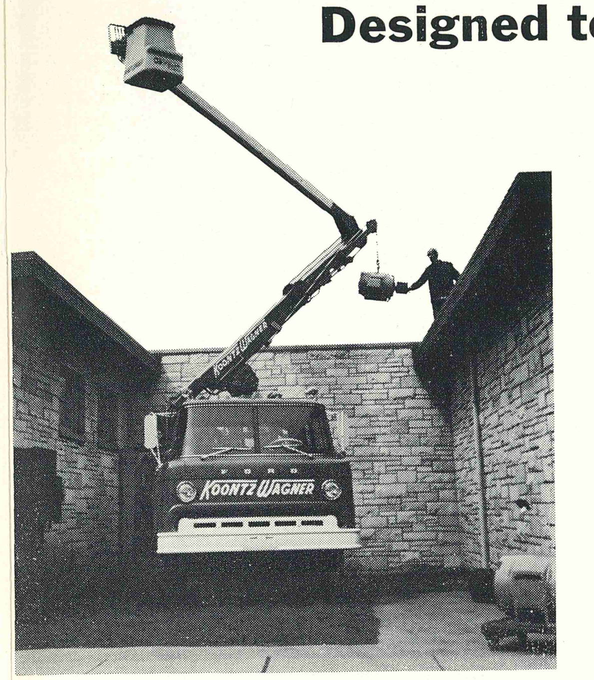
O-B's new district manager in Atlanta is Richard L. MacNary. Dick has excellent qualifications for serving this important territory, being one of those rare graduate electrical engineers with an additional college degree in business administration. His previous position in O-B's home office has been that of sales and application engineer, where he has accumulated almost four years of comprehensive experience with the company's electric utility products and the needs of its utility customers.

O-B takes this opportunity to express best wishes to John Talley in his retirement, to Bill Owens in his new position, and to Dick MacNary as O-B's new district manager.



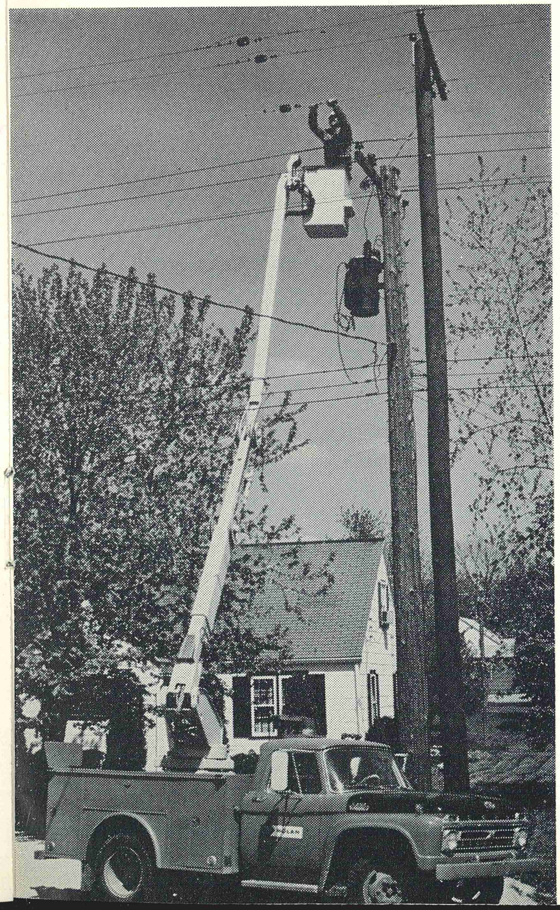
# Designed to be designed by you . . . Bronco 89

## It's your choice - chassis? height? insulation? mounting?




For heavy material handling, select a lower-arm "stinger" boom with hydraulic winch that provides lift capability up to 6,000 pounds for your Bronco 89.

Mounted on either a 60- or 84-inch CA chassis, the Bronco 89-36 includes an integral torsion-bar stabilizer system for assured stability without outrigger jacks — keeps set-up time to a minimum. The optional fiberglass lower-arm insert isolates ground personnel and "sidewalk superintendents" electrically.



Distribution systems are different. Each has its own maintenance needs. Each has its own work situations. That's why Holan engineers developed the versatile Bronco 89. It gives you a choice from the ground up — different CA chassis, two mounting styles, two arm insulation arrangements, and two bucket heights. With a complete list of options to complement the variety of basic choices, you gain maximum flexibility in designing an aerial device to fit your needs when you select the new Bronco 89.

How big an elbow do you need? Bronco 89 lets you select a 41- or 46-foot maximum working height. The 89-36 — 36 feet to bucket bottom — mounts on either a 60- or 84-inch CA chassis and offers a built-in torsion-bar stabilizer system to keep set-up time to a minimum. The Bronco 89-41 — 41 feet to bucket bottom — mounts on a 84-inch CA chassis and includes wide-stance outrigger jacks.

Uniform-stress arm design assures maximum stability and even load distribution for both upper and lower arms. Standard equipment on the Bronco 89 includes a fiberglass upper arm and bucket. Holan also offers a figerglass lower-arm insert for protection of ground personnel and "sidewalk superintendents" in the event of accidental contact with energized underbuild. Whichever arm combination you select, the upper arm moves within a 215-degree radius of the lower arm which pivots 90 degrees from the horizontal. That means plenty of flexibility to reach any work position — fieldside or streetside.

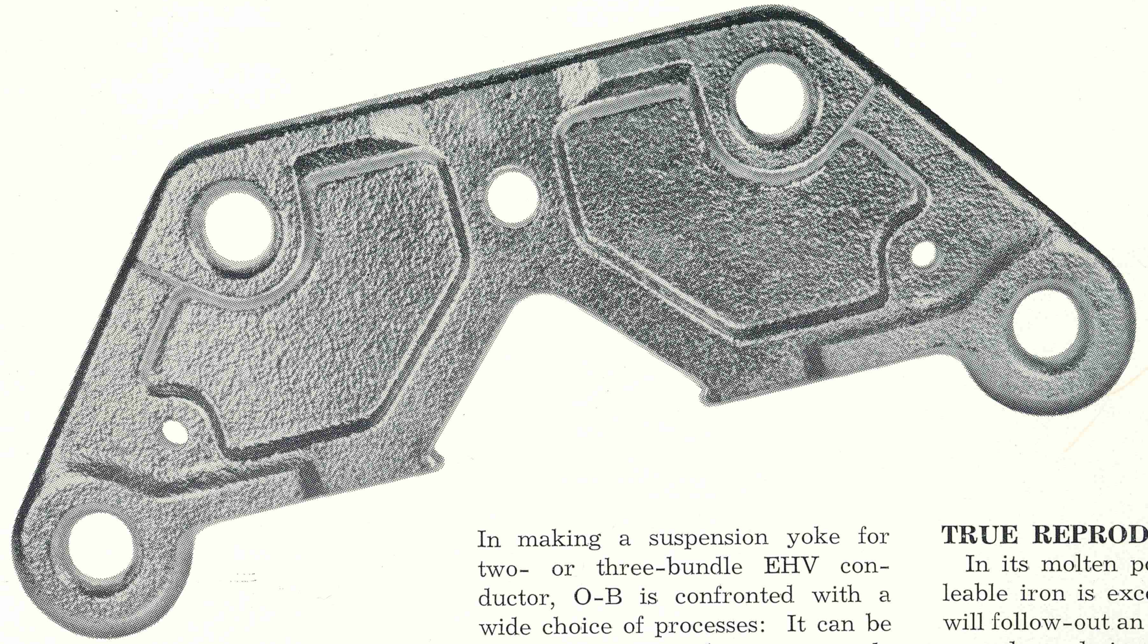
How do you want your aerial device mounted? Bronco 89 gives you two choices — both bridge - type mountings to give you maximum truck bed storage space. If you want a full-line bed for storage of line material, select center-back-of-cab mounting. Your Bronco 89 will be bridge mounted over 25 inches off the floor at the front of the body, leaving nearly the complete truck bed for equipment and material storage. Normally, an extra trailer isn't needed. If you prefer the extra over-the-rear reach of center-over-rear-axle mounting, Bronco 89 offers this, too, in an H-frame mounting configuration. Either way, you've got a stable, well-balanced unit that's maneuverable in town traffic with plenty of capability on the job.

Constant-radius actuation is standard on the Bronco 89 to assure you safe, smooth, and controlled articulation — even when maneuvering up and down a 20 per cent grade. You may even add Holan's optional fully hydraulic safety overload device to insure complete operator safety.

Options help you tailor your Bronco 89 even more to the job it's meant to perform. For material handling, the Bronco 89 may be fitted with a lower arm "stinger" boom with a 6,000-pound capacity. Or, add a winch to the lower arm of the CORA-mounted Bronco 89. Optional remote tool outlets — hydraulic or pneumatic — provide extra versatility at the bucket.

Convenience, capability, versatility, flexibility, and safety are just a few of the reasons Holan engineers designed the Bronco 89 to be designed by you. A call to your Holan representative gets you started. Or, write us direct for additional information and a complete list of optional equipment.

Mounted on a full bridge, the center-back-of-cab Bronco 89 furnishes nearly the full truck-bed area for storage of material and line equipment. Here, the 41-foot CBOC unit is shown on an 84-inch CA chassis with wide-stance outrigger jacks.



# Casting imparts highest utility to O-B suspension yokes for EHV

In making a suspension yoke for two- or three-bundle EHV conductor, O-B is confronted with a wide choice of processes: It can be cast in aluminum, bronze, or malleable iron. We can drop-forge it. We can form it on a punch press. It can be flame cut from a solid plate. We can bend it into any kind of shape, or weld-on parts. And, if there is any question about strength, we can heat-treat it. O-B is a versatile metal manufacturer. We are not wedded to any material or process, and our design engineers are not handcuffed by production compromises.

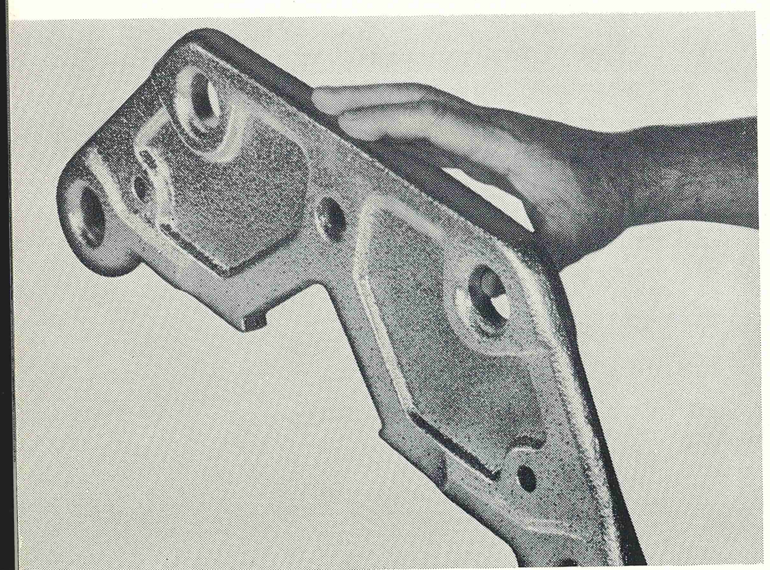
In light of this, one can assume there must be good reasons for the use of cast malleable iron in O-B suspension yokes. We will explore some of these reasons. We think you will see why the casting process is so well adapted to the manufacture of yokes.

## TRUE REPRODUCTION

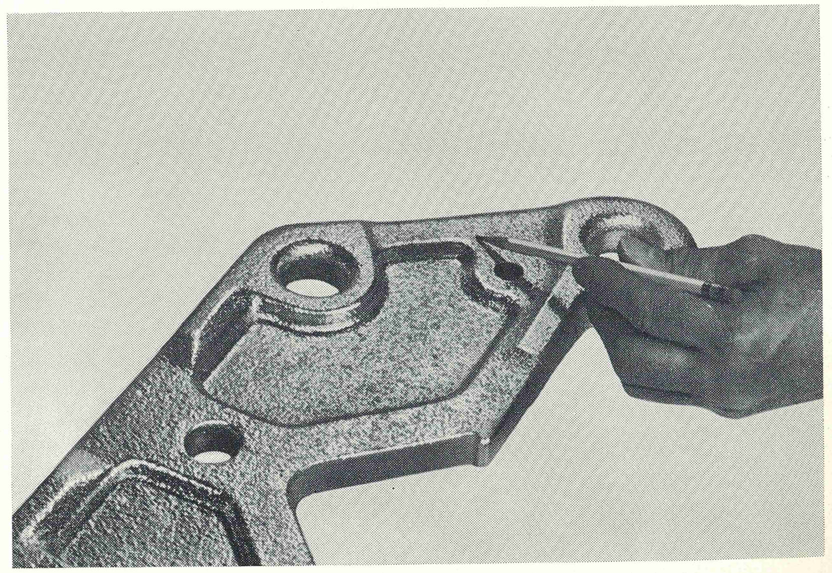
In its molten pouring state, malleable iron is exceptionally fluid. It will follow-out an intricate mold and reproduce design refinements that would be difficult or even impossible with forging, stamping, or cutting processes. There are a number of such details as this in a yoke. For example, the engagement shoulders for hot-line tools shown in "A".

## ROUNDED EDGES

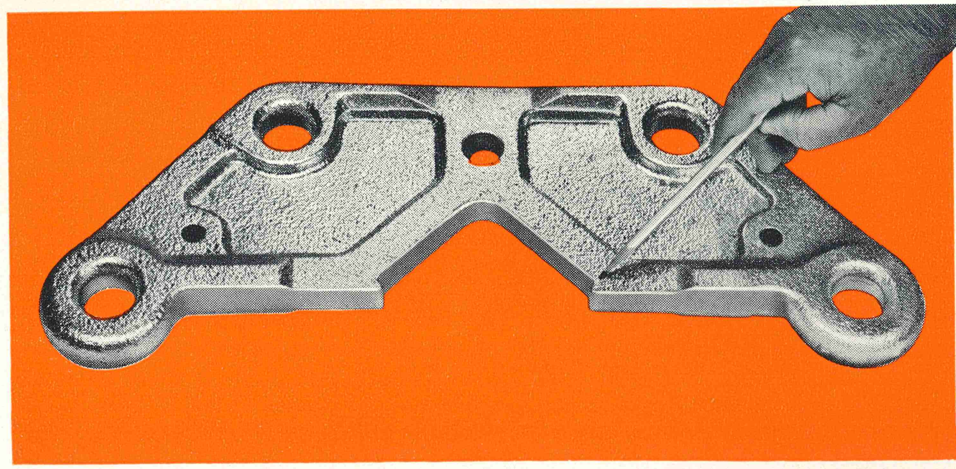
Certain portions of a yoke plate may extend into the critical zone of electrical stress. Here, sharp edges intensify this condition. It has been established in laboratory research and through extensive application experience that adequate corona control can be effected by rounding certain critical outer edges. In forging, this is difficult to perform on a large piece. A stamping or cut piece calls for complete hand-finishing of edges.



**B Rounded outer edges,** essential in the control of corona and RIV, present no problems in a cast piece. Otherwise, the rounding operation may have to be done by grinding or machining . . . laborious processes.



**C Where maximum strength is needed,** additional thickness of metal is easily obtained by casting. Likewise, metal is saved in lighter-loaded sections. Casting aids sound functional design.



**A Small, accurate details,** such as positioning points for hot-line tools, are faithfully reproduced by the casting process. Other common shaping methods cannot form a part with such fidelity.

Rounded edges present no problem in casting. See "B". The desired radius can be reproduced accurately and at no cost penalty. There is no temptation to do only a halfway job of finishing, and get a half-way job of corona control.

## METAL DISTRIBUTION

As with any hard-working mechanical device, certain portions of a yoke are more highly stressed than others. If cut from a flat plate, over-all thickness of material is determined by the greatest mechanical duty existing at some given point. Casting, on the other hand, conveniently puts metal where it is needed. In the O-B yoke there are several heavily reinforced sections, also some relatively thin web sections where strain is minimal. See "C". Casting, in short, permits sound functional design without waste of material or needless bulk.

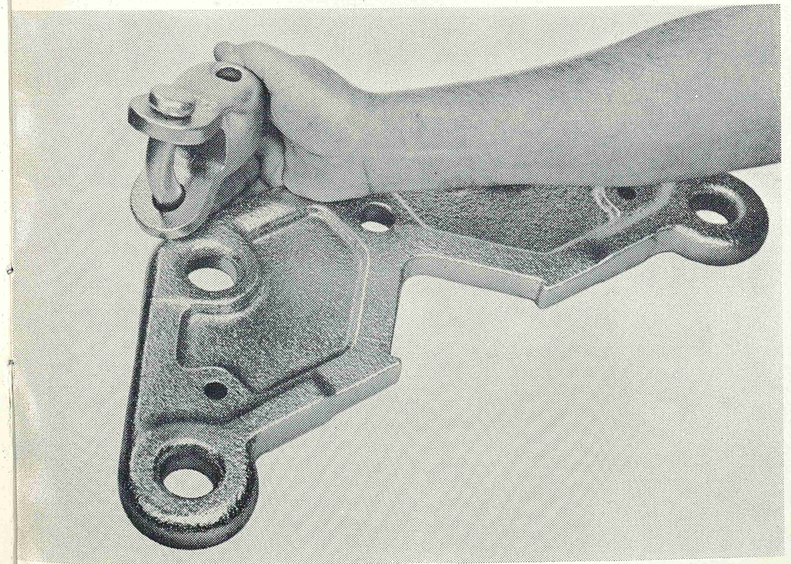
## RELIEVED HOLES

Except in casting, any holes required must be drilled. These naturally have sharp edges. Most fittings connecting with yoke plates utilize curved bolts to provide greater flexibility of attachment. Such a bolt resting in a sharp-edged hole encounters considerable resistance to movement under load, thus partly defeating its purpose. Relieving sharp holes by the chamfering process is a tedious machine operation and is generally avoided. Just like outer edges, with casting it is no trick to round-out the bearing surfaces of holes to accommodate curved bolts and provide maximum free movement. See "D".

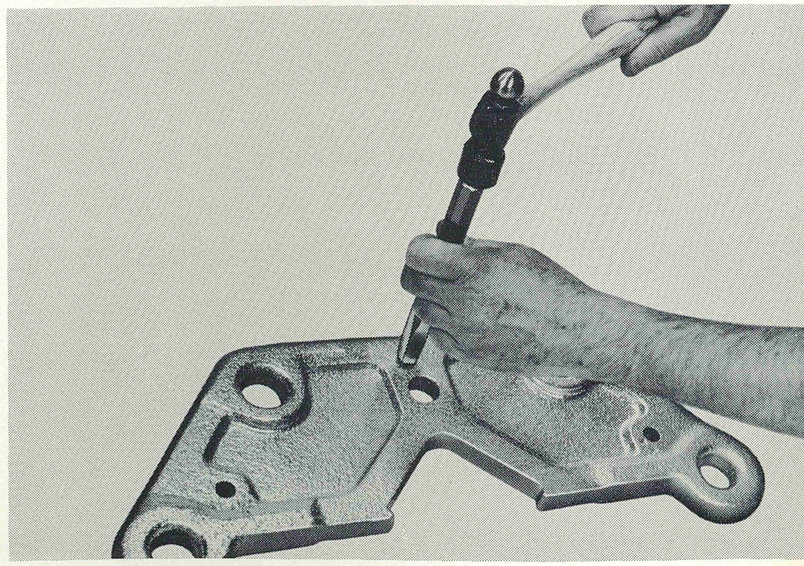
## HIGH DEPENDABILITY

Few people not closely connected with the metallurgical profession fully appreciate malleable iron's ductility. It can be stretched, twisted, and bent without fracture more like some of the pliable nonferrous metals. Within reasonable bounds it is difficult to break a piece of malleable iron.

Once good foundry practice is established, malleable iron is highly consistent in its ability to reproduce sound castings. To search out the occasional flaw, however, the "black light" inspection process is used. See "E". The piece is dipped in a fluorescent solution and is then examined under a special light source. Any concentration of the solution in a crack or fissure reveals itself as a bright yellow line. This process has an outstanding record of accuracy. No other metal can exceed the variety of safety factors present in well-made, carefully inspected malleable iron.



**D Curved bolt fittings** are given maximum freedom of movement when holes have their edges rounded on a long radius. With casting this is a simple operation. With drilled holes it presents considerable difficulty.



**E Soundness of castings** is confirmed by the modern "black light" inspection process that reveals the slightest flaw. When passed, each piece is stamped with a permanent identifying symbol.

OHIO BRASS MANAGEMENT REPORT

# Toughness becomes fashionable but what is toughness?

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

The fashion for a successful business personality has recently changed. For a long time, the successful executive was supposedly the one who achieved popularity with customers, employees, friends, family and community. Now the popularity cult has given way to one that stresses toughness as the key to success.

**AS A NON-HOLLYWOOD TYPE,** I should welcome this change (see my photograph which our advertising people intentionally keep small, I suspect). But I sense and deplore a tendency to equate toughness with ruthlessness. What do you see as the characteristics and actions that denote toughness in the proper sense? Possibly, it starts with being tough with yourself. You should know exactly what you stand for as an individual and as an executive. You should be physically and mentally fit.

**TOUGHNESS INVOKES** the discipline of setting company and industry goals and of communicating those goals to customers and employees in terms they can understand, so that understanding will bring enthusiastic participation and cooperation . . . for the benefit of both the individual and the company.

**TOUGHNESS IMPLIES** acceptance of uncertainty. Data processing reports, critical path methods, program evaluation and review techniques and the other

charting and data reporting methods can take some of the uncertainty out of business. But you must still operate in areas of uncertainty. Decisions must be made on the basis of incomplete information. The company manual can only cover solutions to the obvious problems.

**TOUGHNESS CALLS FOR** concentration on profitability. It calls for cutting out the procedures, reports, habits, and pet projects which deter profitability. But it may demand spending more money rather than less in the interests of long range profitability.

**WE DON'T SEE THE TRULY TOUGH EXECUTIVE** as a swashbuckling domineering fellow wielding his sword of authority for the cause of progress at all costs. But as a man of inner toughness. He may never raise his voice in anger or ridicule. But he has mastered the disciplines that will take his company, his employees and his customers forward. 743-H

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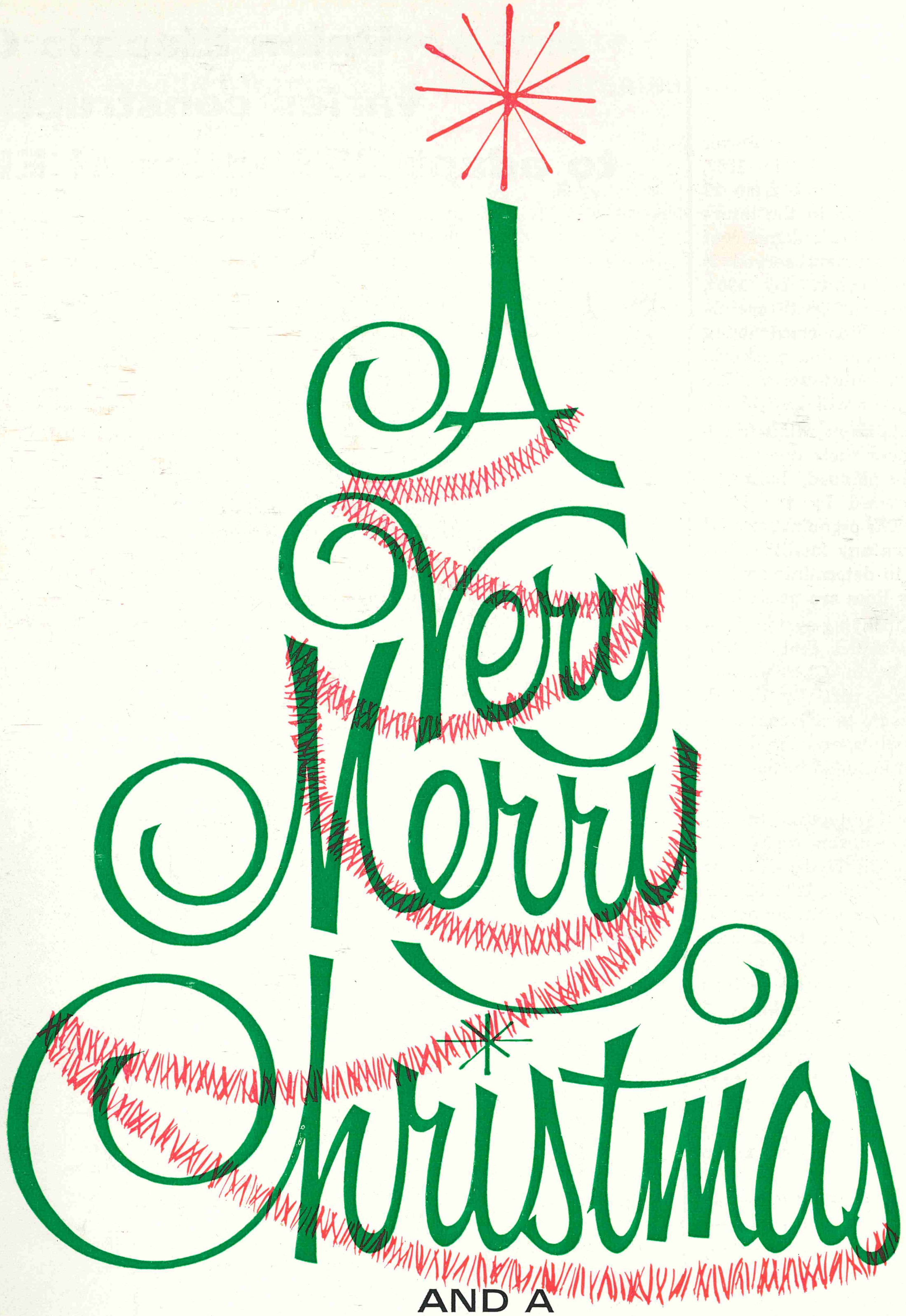



AND A HAPPY NEW YEAR

OHIO BRASS

## . . . a brief glance at the MAPP project

MAPP (Mid-Continent Area Power Planners), formed early in 1963, has grown in membership from 22 to 39 power suppliers in the intervening few years. Peak demand of the 3,250,000 consumers served is presently 7,500,000 kw. By 1980, member utilities anticipate spending about $250 million constructing a 5,400-mile transmission network, with associated substations. The bulk of these lines will be 345 kv.

All MAPP members retain complete control over their operations. Construction is planned, built, financed, and owned by the individual ultities. The organization will not build or own any facilities, but will cooperate in determining when and where new lines are needed.

On the accompanying system layout it will be noted that certain lines originating in Chicago and Kansas City are partially dotted. This indicates a tie to adjacent systems at these points, and the dotted sections are not included in the total MAPP mileage.

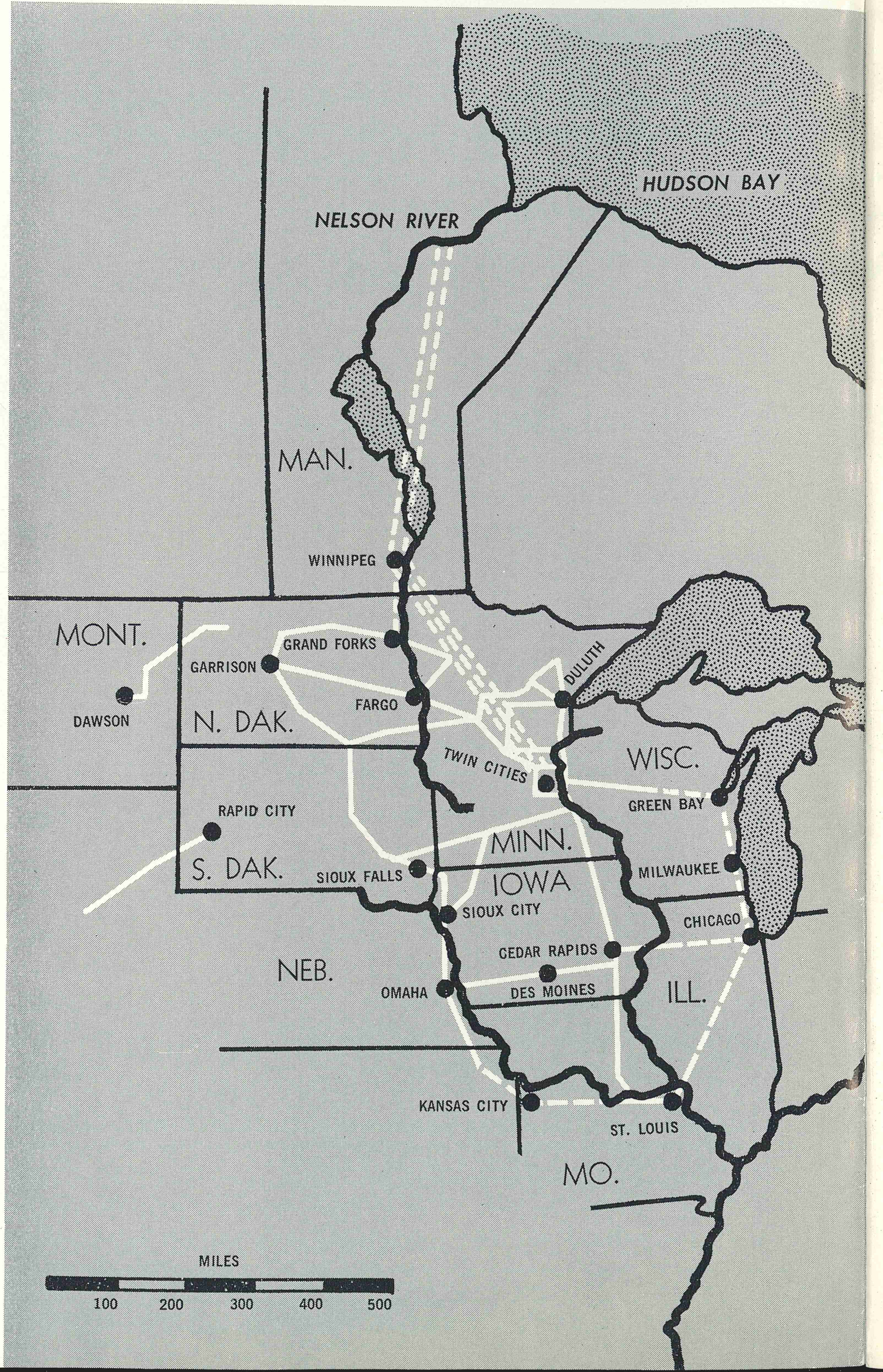
Of exceptional interest are the lines dotted-in centering on Winnipeg, Manitoba. The Hydro-Electric Board of this province is a MAPP member, and has now under active investigation a project to harness the potential hydro power of the Nelson River which could deliver over 4,500,000 kw into the heart of the MAPP system. This would be accomplished by two long circuits originating at generation sites, which would break down into three circuits between Winnipeg and Twin Cities, and a fourth circuit to Grand Forks.

Of the total projected 5,400 miles of line, there are presently 10 new lines completed, under construction, or authorized, constituting 3,350 miles. Of these, 2,110 miles are at 345 kv, 990 miles at 230 kv, and 250 miles at 115 kv.

Portion of the system covered in this report is the section of line running west from St. Louis.



# Union Electric Co. varies construction to adapt 253 miles of EHV to local environment




## Joint use of steel towers, choice of single or V-string insulation, wood H-frame, all worked to greatest advantage

As part of the MAPP development program, Union Electric Company of St. Louis is now engaged in building a 253-mile section of line to operate at 345 kv. Perhaps the most interesting characteristic of this line is the adaptation to the area it crosses: (A) Use of V-string construction in districts of restricted right-of-way. (B) Employment of less expensive construction with vertical single-string insulation where proved in by cost and the availability of land. (C) Double-circuit construction on 58 miles of existing steel towers, with the original circuit now operating at 161 kv. (D) Wood H-frame for 187 miles. This flexible approach to design fits a major EHV line into the U. E. system, taking practical advantage of various factors of environment.

Portion of the Union Electric Company system discussed here is built jointly on steel towers, sharing the present 161-kv circuit. This circuit will later be rebuilt for 345 kv. The joint construction exists on all but eight miles of the total 66-mile steel tower section. This section starts at St. Louis and runs west on steel to the turning point north, as will be seen by reference to the attached map. At the turning point, wood H-frame construction will then extend north for 187 miles to an interchange of ownership near Cedar Rapids, Iowa. At the time of preparing this material, only a few miles of poles had been set on the wood H-frame section. A full discussion of U. E.'s use of wood at

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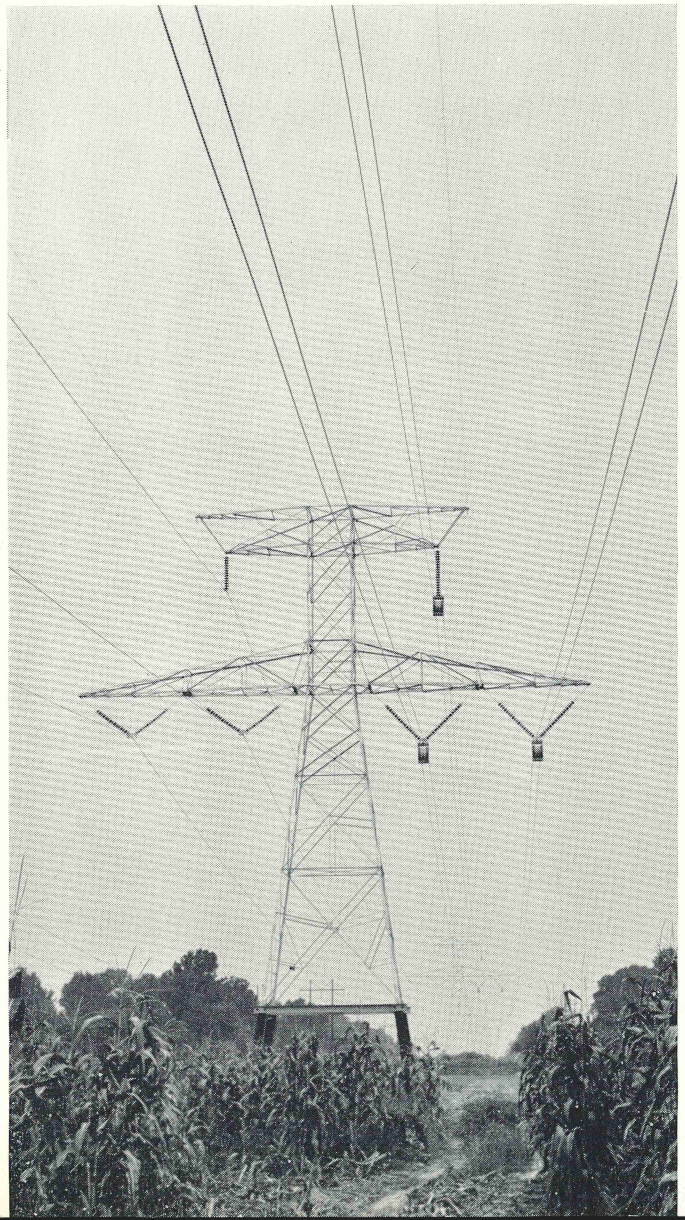
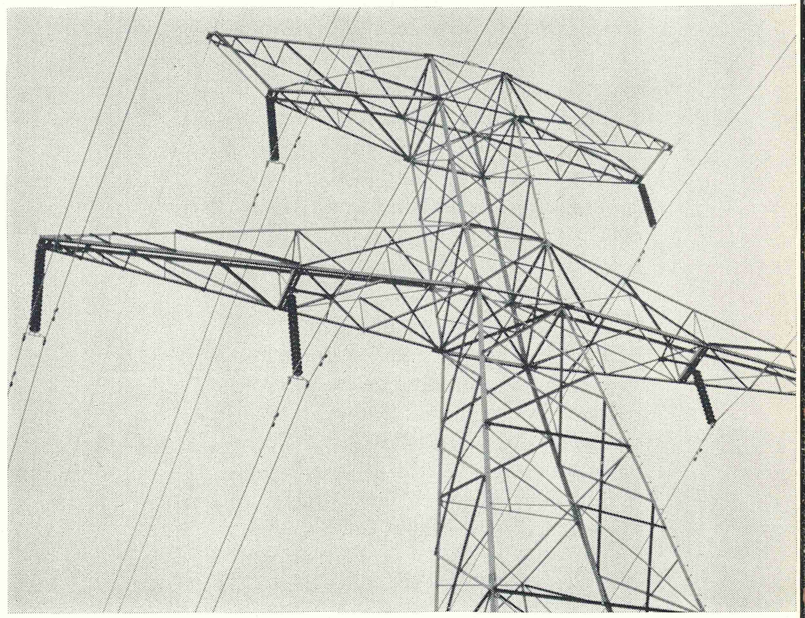




Single vertical insulator strings are used in unrestricted areas. This, and comparable V-string construction, are employed interchangeably for 58 miles, as dictated by local right-of-way conditions.

Restricted right-of-way construction using V-strings on the lower arm that rules width of the line. "V" insulation permits two circuits to be supported on a 91-foot, 6-inch cross-arm. The left circuit is presently 161 kv, but will later be raised to 345 kv. For most of the 66-mile section built on steel towers, right-of-way was already established. In many portions, however, it is quite narrow, and these are labeled "restricted" in line plans. The ability of V-strings to save approximately 20 feet of width declared their use in such restricted areas. Where a wider right-of-way was already existing, or readily available, it permitted more economical single-string insulation. See Figures 1 and 2 for more tower detail. Note heavy base extensions on tower legs to protect during annual flooding.

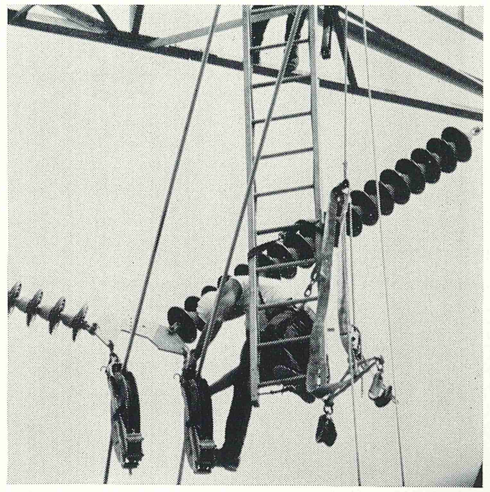
*(Continued from previous page)*
345 kv will appear in a later issue of Hi-Tension News when all construction steps can be illustrated.

Steel towers have an average span of 1,170 feet, extended to 1,350 feet in certain restricted areas. Double conductors consist of ACSR, 954 MCM, 54/7, Cardinal, design tension of 14,000 pounds at zero degrees and ½-inch radial ice. Ground wires are 7/16-inch, 7-strand, aluminized steel.

All tangent insulation, whether "V" or single vertical strings, consists of 18 ball-socket units of 15,000-pound rating. Deadends are built with double strings of 20 units with 36,000-pound rating. Tower footings are brought to a resistance of 18 ohms by means of driven ground rods and counterpoise where necessary. Lightning shielding angle on V-string structures is 15 degrees, and on vertical insulation structures, 19 degrees. The line is computed for one lightning outage, or less, per 100 miles per year, in a 50-storm-day district.

Typical of the majority of EHV mileage built or under construction today, the 253 miles of 345 kv of Union Electric Company will be completely equipped with O-B insulators and conductor hardware.

This component of the huge MAPP program well illustrates some of the benefits to be derived by member utilities. At the northern end of the Union Electric Company jurisdiction, the line will extend under different ownership to Minneapolis-St. Paul (Twin Cities), for a total length of 510 miles, and the joint project is referred to as the St. Louis-Twin Cities circuit. The line, scheduled for completion in May 1967, will facilitate exchange of power within a territory from North Dakota to St. Louis and from Wisconsin to Nebraska. This power exchange, involving an estimated 550,000 kw, will permit deferral of otherwise immediate need to construct four new generating plants with a capacity of 700,000 kw, at a cost exceeding $100 million. Such a deferral not only yields a present saving of major proportions but will also make it feasible to build even larger facilities later.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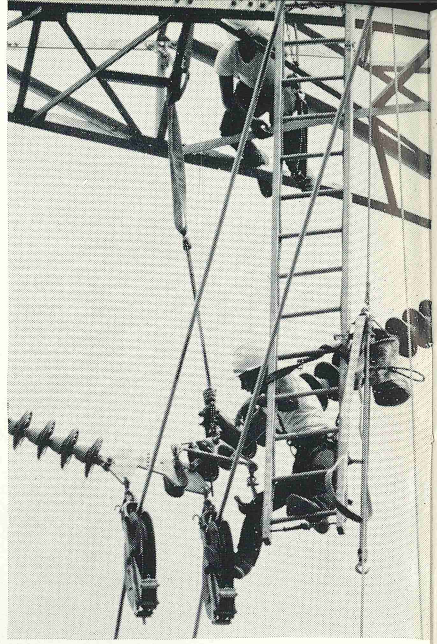
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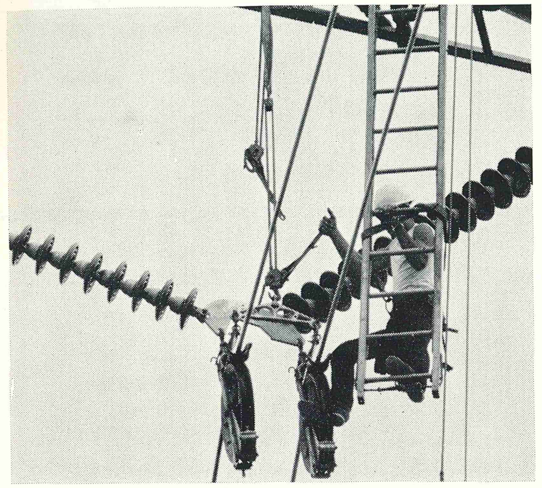
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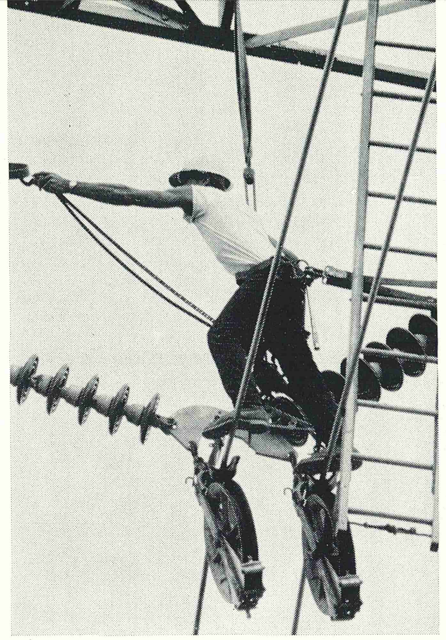
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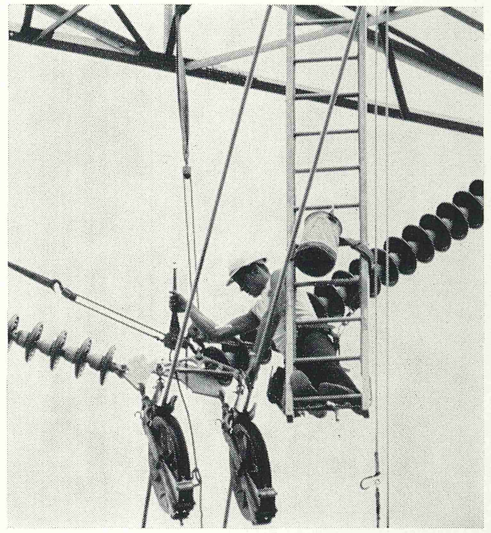
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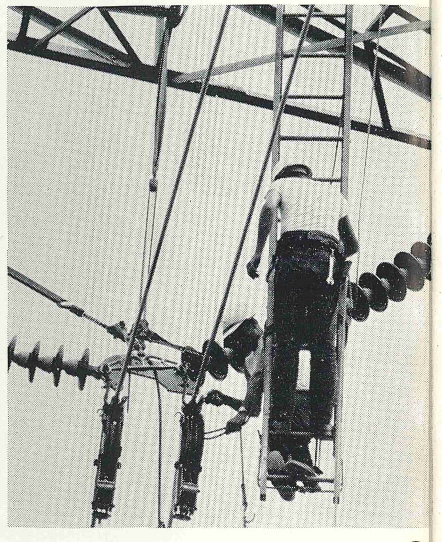
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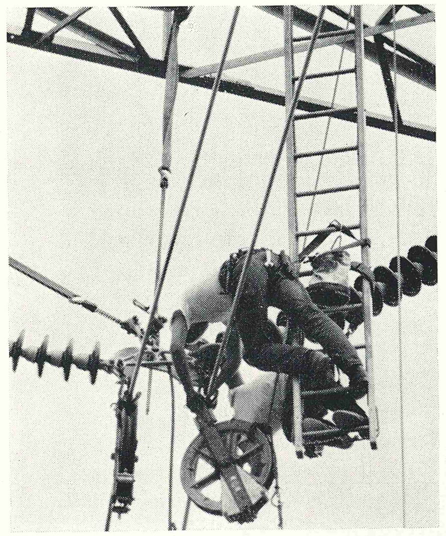
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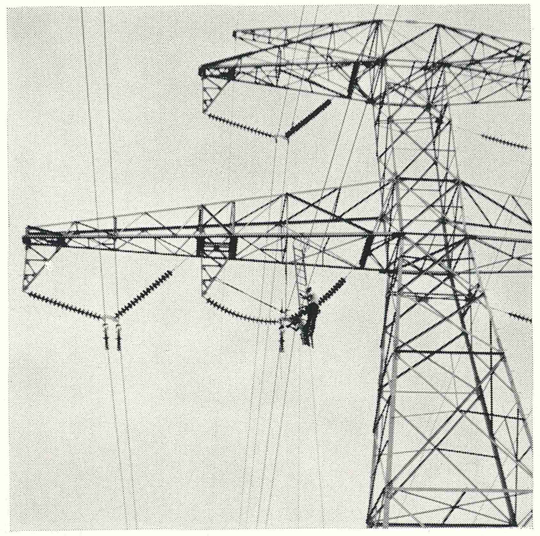
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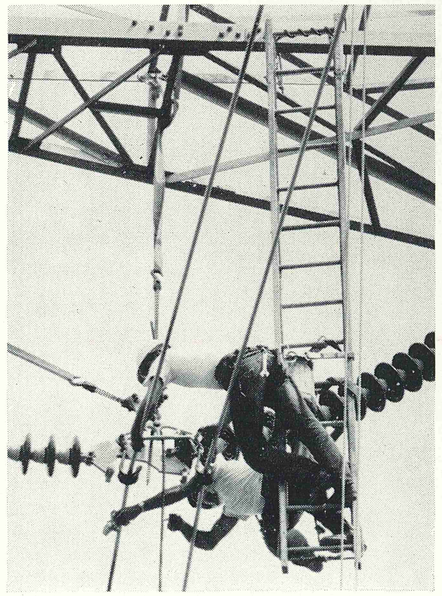
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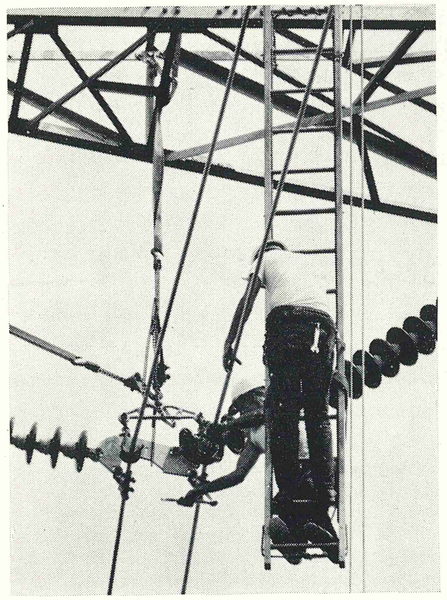
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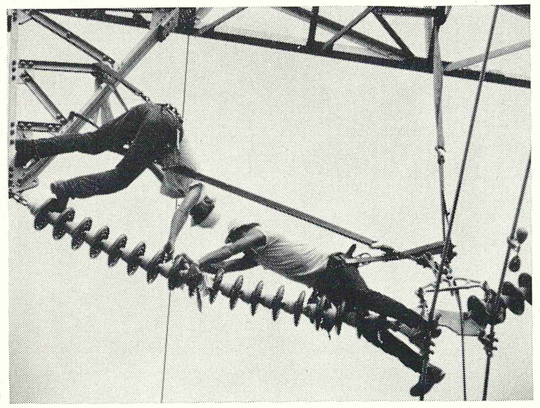
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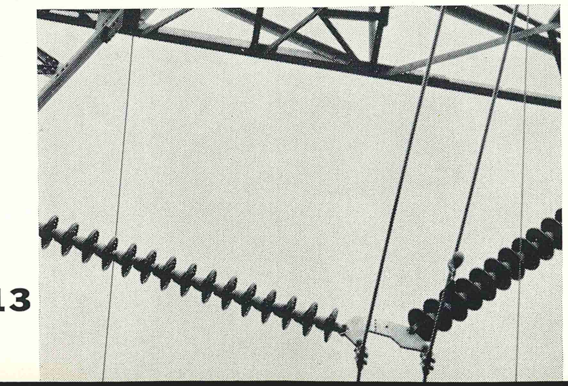
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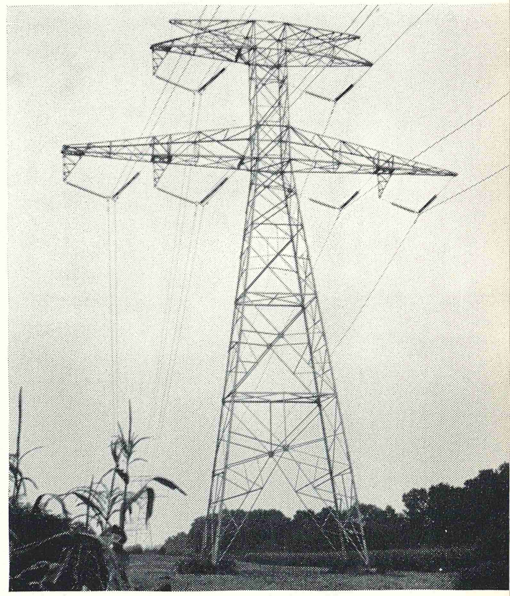
Many people enjoy studying construction methods used by various builders, especially where bundle conductors and V-strings are involved. The accompanying series may have special interest, since it shows a clipping-in procedure on an angle tower where normal weight of conductors is complicated by considerable side strain. Photographs are numbered in successive steps. As the reader progresses, a few comments may be in order. No. 1 is intended primarily to illustrate the lifting device consisting of padded hook-shape saddles attached to a conventional yoke. No. 4 shows preparation for attaching a second hoist to add side pull to the normal lifting operation, to hold conductors in their proper location. In No. 9 the lineman is attaching the suspension clamp loosely to the conductor. Afterwards it is moved into position, attached to the yoke, and tightened. No. 12 shows an operation related only to ball-socket insulators. With weight still on the hoists and the insulator strings unloaded, men are orienting all units in the string for easy access in the possible event of hot stick work. No. 14 is a completed angle tower. Note that in such construction full V-string insulation is used because of its efficient support of side strain.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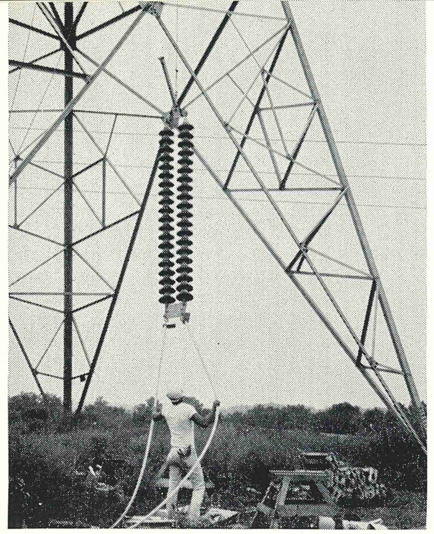
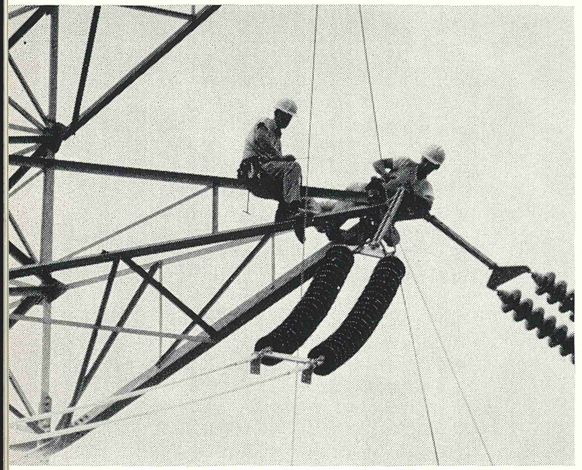


**Figure 1**—Because both circuits eventually will be 345 kv, this ultimate construction is used in these examples. With the particular design of double circuit towers of Union Electric Company, it will be seen why considerable freedom exists in the application of vertical vs. V-string insulation. In this figure illustrating vertical insulation, crossarm length is 78 feet. Assuming a 40-foot sag and 40-degree wind blow-out at mid-span, the line has a possible width of 144 feet between energized outer conductors.



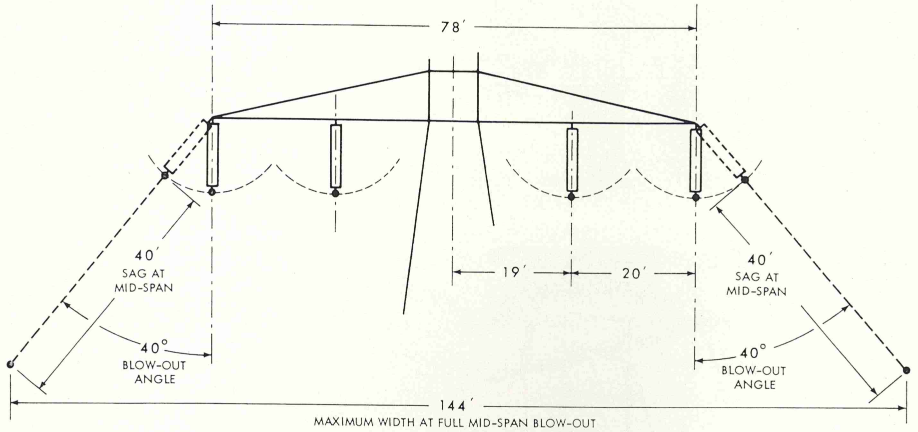
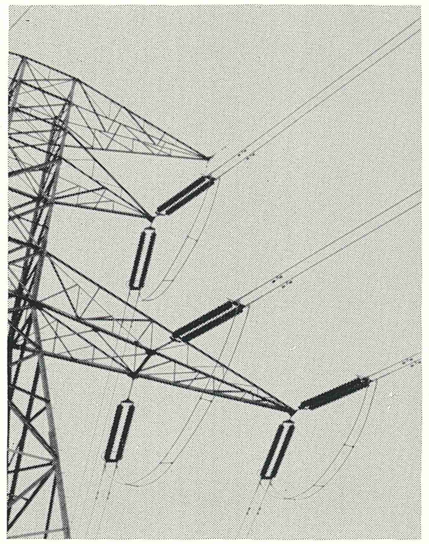



FIG. 1



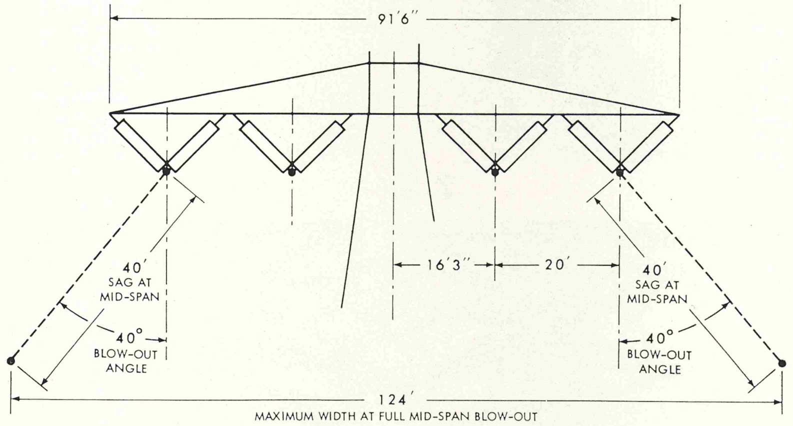



FIG. 2

All deadends consist of two yoked strings of 20 ball-socket insulator units each, with 36,000 pound rating.

**Figure 2**—To mount V-strings on this tower design, 13 feet, 6 inches more of crossarm is required. Because of the restrained conductor support, however, the maximum wind blow-out width of the line is 20 feet less than Figure 1. Additional structure and insulation cost of the arrangement is compensated by slightly longer spans that save one-half tower per mile and, more important, by enabling U. E. to take advantage of the existing right-of-way. These factors dictate V-string construction in "restricted" areas, and single vertical insulation where greater width is available. These two types of construction occur interchangeably throughout the double-circuit, steel tower section of the line.



# Two new SYSTEMS keep Holan's Charger 82 squirt boom "on the level," take up slack in control line

## Two significant engineering advances combine with exclusive "HOLSTAT" control system to assure safe and reliable operation of telescoping aerial devices

Automatic leveling of the bucket is essential to the safety and sense of security of the operator of an aerial maintenance unit. Holan accomplishes the leveling function hydraulically on the new Charger 82 by using a constant-radius mechanism that translates changes in angular position to changes in hydraulic cylinder volume.

A master hydraulic unit is located between the boom and base, while a slave hydraulic unit is positioned between the boom and bucket. Enclosed within the lower boom, a double-acting hydraulic cylinder attaches to chains which are reeved over a pair of sprockets. One sprocket is fixed to the movable member (lower boom) and rotates about a shaft fixed to this reference member. As the angle changes between the lower arm and base, the fixed sprocket drives the chain over the idler sprocket moving the attached cylinder with respect to its piston and rod.

Cylinder volumes above and below the piston connect between the master and slave, permitting the slave unit to rotate the bucket through an angle equal to that of the master unit connected between the boom and base. No motion of bucket relative to boom can occur without a change in angular relationship between boom and base.

As the telescopic boom moves in and out, compensating for changing lengths of control line becomes a problem. Length compensation and loop storage is necessary to prevent stressing and abrasion of the multiple signal control line which runs from the control module in the lower arm to the operator control station at the bucket. The second new device used on the Charger 82 controls this operation.

Holan engineers designed an endless cable mechanism to solve the storage and compensation problems. Sheaves attached to the movable boom section are driven with a rotary motion by an endless steel cable attached to the fixed boom section. The multiple signal control line is reeved around one of these sheaves so its two strands form a "U" with one strand fastened to the extendible boom, the other to the fixed boom.

Extension or retraction of the outer boom rotates the sheave, transferring equal lengths of control line between the two strands. Since the combined length of the two strands remains constant, the control line pays out without strain.

By mounting the sheaves at opposite ends of a unique spring-loaded spacer assembly, compensation for change in length because of thermal expansion is also provided.

For additional information about the Charger 82 -- or these two new unusual and integral systems -- write Holan, Division of The Ohio Brass Company, Cleveland, Ohio.

Equipped with Holan's revolutionary new "HOLSTAT" Control System, the Charger 82 is one of the industry's most responsive and dependable telescoping boom aerial devices. Two other unusual engineering features -- one for keeping the bucket level, one for length compensation of the control line -- are explained in detail in this article. Note that the cover has been removed to reveal the mechanism for controlling the length of the control line.

BALL-SOCKET TYPES

LINE 1 CONVENTIONAL PIN

| Catalog No. | | 32436 | ASA CLASS 52-3<br>32440 | 32434 | HIGH IMPACT<br>34500 | 48008 | 48508 |
|---|---|---|---|---|---|---|---|
| Diameter | In. | 10 | 10 | 7½ | 10 | 9½ | 9½ |
| Section Length | In. | 5 | 5¾ | 5¾ | 5¾ | 5¾ | 5 |
| M & E Strength | Lbs. | 15,000 | 15,000 | 15,000 | 15,000 | 14,000 | 14,000 |
| Impact Strength | In./Lbs. | 55 | 55 | 50 | 90 | 55 | 55 |

LINE 2 FUTURA SERIES

| Catalog No. | | 47720 | 47610 | 47400 | ASA CLASS 52-5<br>47410 | 47300 | 47310 | 47450 | SMOGTYPE INSULATORS<br>47460 | 47350 | 47360 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter | In. | 11½ | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Section Length | In. | 6⅛ | 5¾ | 5 | 5¾ | 5 | 5¾ | 5¾ | 6½ | 5¾ | 6½ |
| M & E Strength | Lbs. | 50,000 | 36,000 | 25,000 | 25,000 | 18,000 | 18,000 | 25,000 | 25,000 | 18,000 | 18,000 |
| Impact Strength | In./Lbs. | 125 | 90 | 90 | 90 | 90 | 90 | 30 | 30 | 30 | 30 |

CLEVIS TYPES

LINE 3 CONVENTIONAL PIN

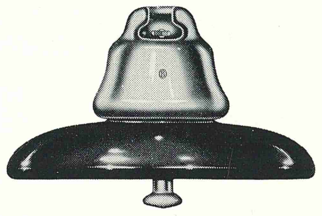
| Catalog No. | | HIGH IMPACT<br>35301 | ASA CLASS 52-4<br>32439 | DISTRIBUTION<br>ASA CLASS 52-2<br>32435 | 48019 | DISTRIBUTION<br>32399 | DISTRIBUTION<br>ASA CLASS 52-1<br>32433 |
|---|---|---|---|---|---|---|---|
| Diameter | In. | 10 | 10 | 7½ | 9½ | 4¼ | 6 |
| Section Length | In. | 5¾ | 5¾ | 5¾ | 5¾ | 6¼ | 5½ |
| M & E Strength | Lbs. | 15,000 | 15,000 | 15,000 | 14,000 | 10,000 | 10,000 |
| Impact Strength | In./Lbs. | 90 | 55 | 50 | 55 | — | 45 |

LINE 4 FUTURA SERIES

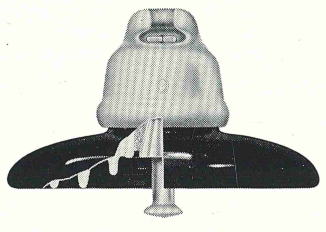
| Catalog No. | | 47725 | 47615 | ASA CLASS 52-6<br>47415 | ASA CLASS 52-4<br>47315 | SMOGTYPE INSULATORS<br>47465 | 47365 |
|---|---|---|---|---|---|---|---|
| Diameter | In. | 11½ | 10 | 10 | 10 | 10 | 10 |
| Section Length | In. | 7 | 6¼ | 5¾ | 5¾ | 6½ | 6½ |
| M & E Strength | Lbs. | 50,000 | 36,000 | 25,000 | 18,000 | 25,000 | 18,000 |
| Impact Strength | In./Lbs. | 125 | 90 | 90 | 90 | 30 | 30 |

Essential mechanical characteristics of all regularly listed O-B suspension insulators, arranged in descending order of M&E strength. In the second and fourth lines, Smogtype units are separated from regular designs. Units conforming to the ASA Standard are indicated. Units intended primarily for distribution are also marked. Refer to O-B catalog for complete mechanical and electrical data.

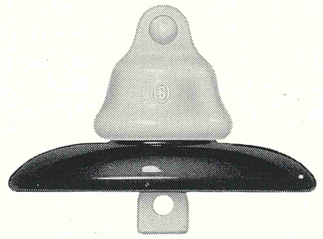
Line one -- typical ball-socket, conventional pin design. The six variations of this unit, and their mechanical and electrical characteristics, are described on pages 46 and 47 of O-B Insulator Catalog No. 42.



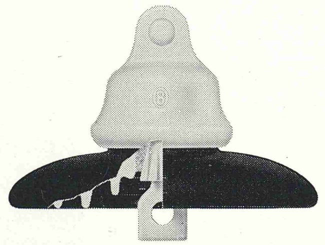
Line two -- typical ball-socket design in the Futura series. The six variations of this unit, and their mechanical and electrical characteristics, are described on pages 40 and 41 of O-B Insulator Catalog No. 42. The four Smogtype units also shown in line two are described on pages 42 and 43.

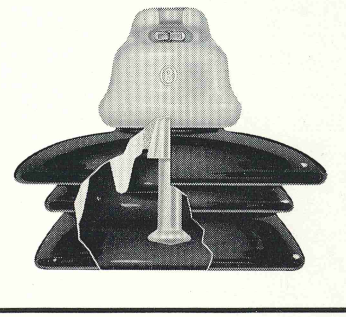


Line three -- typical clevis type, conventional pin design. The six variations of this unit, including three distribution types, and their mechanical and electrical characteristics, are described on pages 48 and 49 of O-B Insulator Catalog No. 42.



Line four -- typical clevis type in the Futura series. The four variations of this unit, and their mechanical and electrical characteristics, are described on pages 44 and 45 of O-B Insulator Catalog No. 42. The two Smogtype units also shown in line four are described on pages 42 and 43.





Application of the ball-socket Futura pin to a typical Smogtype suspension insulator. Clevis connection follows identical practice.

# Save time and confusion with this "looker's guide" to suspension insulators

By the time a transmission line reaches the stage of final design, a host of insulator details will have been explored by engineers. No brief tabular presentation of data would suffice for this purpose. But there are countless occasions in purchasing and engineering departments when a quick look is very desirable in attempting to narrow-down the field or fit a certain insulator into a certain requirement. The inevitable complexity of cataloging practice does not always lend itself to such a quick look. Because of this, the accompanying presentation of O-B insulator data may be quite useful in dealing with some of the more general questions. It can be particularly valuable in helping one classify various insulator types, and the available models within these types.

Most preliminary considerations center on methods of interconnection (ball-socket or clevis), dimensions, and M&E strength ratings, with occasional reference to impact strength. We have taken these factors and applied them to all regularly listed O-B suspension insulators. Reading from left to right across each line, it will be seen that data appears in order of descending M&E strength. Where several units have the same strength, an effort has been made to put them in logical sequence.

Two main classifications, ball-socket and clevis connections, are divided into sub-classes of conventional pin design and the O-B Futura series. Smogtype units are separated for clarity. Units intended primarily for distribution service are identified.

In each class, ASA Standard designs are noted. It is sometimes the case that, in borderline decisions, the ASA Standard is favored. This Standard, however, is intentionally limited to a few general types, and the user must not confuse "non-standard" with "off-standard." The great variety of insulator requirements, today, has necessitated a corresponding variety in the merchandise we have on display.

Insulator buyers are generally familiar with the O-B Futura design. This is an exclusive, patented, O-B feature. Pin corrosion within cement results in formation of oxides that have greater volume than the original metal. Growth of this oxide film imposes high localized bursting stress on the porcelain shell. Many insulators have been destroyed by this condition which, of course, occurs in varying degrees of severity. In the richly ozonized area of the pin, however, oxidation is a very prevalent condition.

By surrounding the pin with a sleeve, thus imposing a generous air space between the lower end of the pin shank and the cement, physical effects of the presence of an oxide film are neutralized. As a result, the Futura insulator design represents an almost infinite improvement in corrosion resistance.

Likewise, the long unimpeded shank of the pin has considerably more flexing action and imparts to the insulator a high degree of immunity to damage resulting from aeolian vibration on conductors.

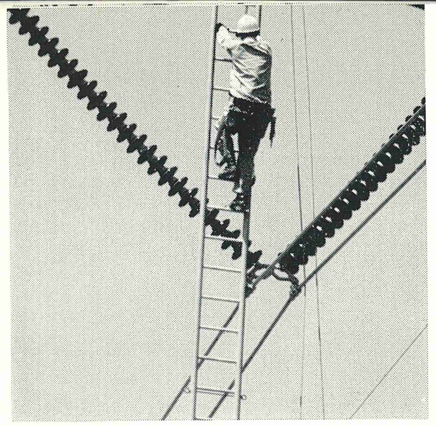
Smogtype insulators utilize extended porcelain petticoats to increase surface leakage length. These insulators are extremely effective in locations of severe atmospheric contamination.

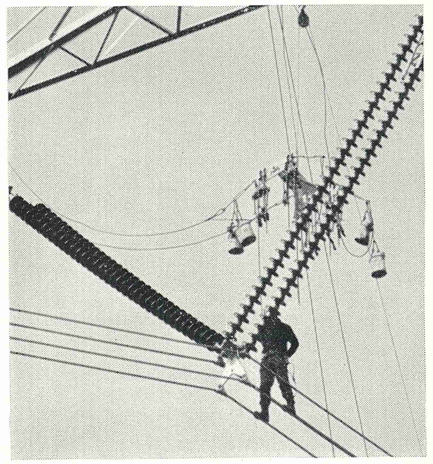
While the transmission engineer may have no immediate interest in distribution insulators, these are shown in order to keep the classification complete. On the other hand, this engineer may welcome these listings if he is seeking a unit in the distribution category for some special ground wire treatment. In this connection, we did not include in the tabulation insulator No. 41799 listed on page 49 of the O-B insulator catalog 42. This unit is specialized, and limited only to ground wire application where it is desired to have insulation combined with minimum flashover.

As we said at the start, the attached data is in no sense a "buyer's guide" for major insulation. It is simply a "looker's guide," but may save much time and confusion.

# How do you design an insulator-hardware "system"?

## O-B engineers develop your new EHV line's support after a component-by-component check with your specifications!





Where would *you* begin to design and develop the complete insulator-hardware assembly for your new line? For most line designers, the initiation starts with stacks of catalogs, performance and test data, design claims, and other information which must be thoroughly studied and digested before approaching the drawing board. Each component must fit naturally with every other, and perform like it was cast in the same mold. It would also be helpful to have a large laboratory available for detailed proof-testing of your final design. The alternative? - give O-B your specifications and let 10,000 miles of modern EHV experience go to work.

With your line specifications in hand, your O-B engineer begins a component by component check of insulators, clamps, yokes, and fittings to develop a combination that best fits your needs. He starts at the line end with the conductor support, selecting the correct clamp seat for your conductor size. Further analysis of your conductor size, stringing tensions, phase spacing, tower placement, minimum and maximum loading, and environmental conditions permits determination of the most critical suspension clamp dimensions -- the correct distance from the center line of the cotter bolt to the center line of the conductor, over-all clamp length, and the seat approach angle. Proper proportion of these elements assures a balanced relationship for optimum performance.

Preceding construction of a two-, three-, or four-conductor EHV line, a detailed analysis of each insulator-hardware assembly component must be made to assure the electrical and mechanical compatibility of the complete assembly.

With the correct clamp dimensions determined, your O-B development engineer selects the exact O-B aluminum clamp body designed for the job. A custom-manufactured keeperpiece then combines with the clamp body to furnish a snug support for your specific conductor size. Close natural fit and maximum surface contact between clamp, keeperpiece, and conductor result to assure even distribution of keeper pressure and prevent distortion of conductor strands.

Connecting clamps to the remaining assembly requires inclusion of a strong "flexible" support. O-B development engineers prefer the use of a wye-clevis-eye fitting with a 90-degree curved bolt for maximum protection during mechanical cycling. The wye-clevis fitting permits wrist-like movement in any direction to protect clamp, conductor, and yoke from possible damage created by a physical bind between components. High strength is another advantage of the wye-clevis eye. The basic fitting is cast of malleable iron, then combined with a ¾-inch or ⅞-inch curved bolt which supplies a broad bearing surface for connection to the yoke. For long life, each fitting receives a hot-dip galvanized coating of corrosion-resistant zinc before shipment.

Next, the O-B development engineer begins designing the heart of the insulator-hardware system -- the yoke. Extensive and concentrated research directed toward yoke design development in the early years of modern EHV transmission gave O-B engineers the basic ringless, close-coupled, and stabilized yoke-design principles which govern development of an O-B yoke. Described in U. S. patents, these basic foundations permit development of a mechanically stable yoke which will perform interdependently with the remaining assembly components, and offer several line performance benefits.

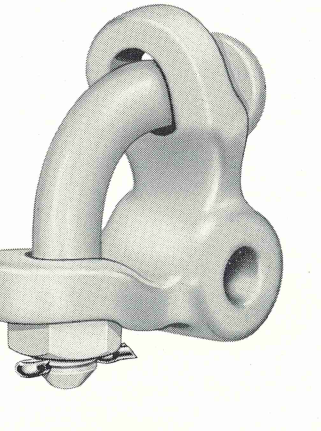
As the focal point of all applied forces, the yoke may be subject to severe racking and twisting resulting from the reaction of the bundled conductors to fault currents, ice unloading, or extreme gusting winds. Judicious selection of the yoke shape, clamp attachment points, and the attachment point(s) for the insulator string(s) results in an assembly that will protect rather than destroy itself during transient displacements. With the cage-like bundle of conductors positioned up toward the line-end insulator, control rings may usually be eliminated. Close coupling between insulators, yoke, and clamps keeps all assembly components within the smallest phase spacing, permitting possible reductions in tower width and right-of-way.

Use of malleable iron in most O-B stabilized yokes assures accurate design reproduction and high strength. O-B's modern casting-manufacturing facilities permit faithful reproduction of rounded corners for optimum RIV performance, and toroidal-shaped attachment holes for maximum wear resistance. Controlled distribution of metal during yoke manufacturing insures the desirable high strength characteristics.

Another application of O-B's wye-clevis fitting links the yoke and insulator string(s) -- either ball-socket or clevis-type units. Again, the flexibility of the wye clevis furnishes protection during mechanical cycling. The insulator strings are subject to no twisting or jerking motions, and remain under tension loading at all times.

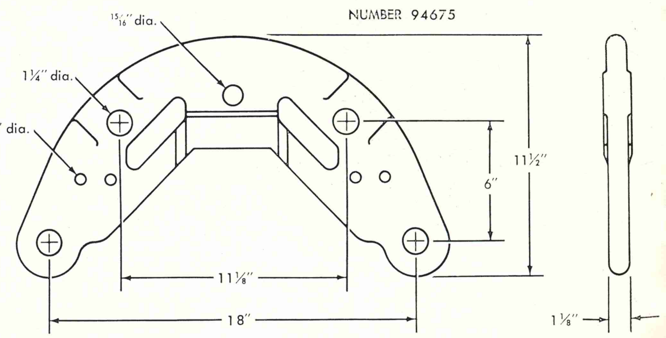
O-B suspension insulators of the required M & E rating are then added in the string quantities required for adequate insulation. Balanced electrical design, regulated application of compressive stress on the porcelain, and optimum recovery ability in all O-B suspension insulators mean an electrically and mechanically stable insulated support for your EHV transmission line. Since their introduction on the premier EHV line (115-kv line from Niagara Falls to Toronto, Ontario) in 1909, O-B suspension units have pioneered insulator develop-

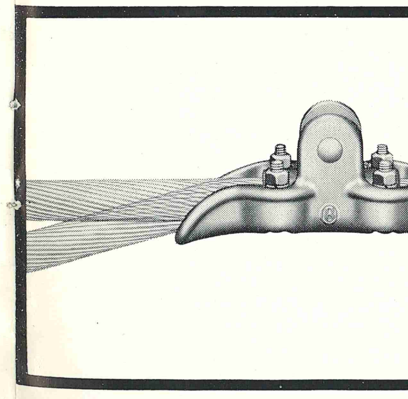
*(Continued on next page)*



Strong "flexible" support -- that's the definition of O-B's wye-clevis-eye fitting, with its 90-degree curved bolt for attachment. The wrist-like movement of the curved bolt protects clamps, yoke, and insulators from severe binds between components.

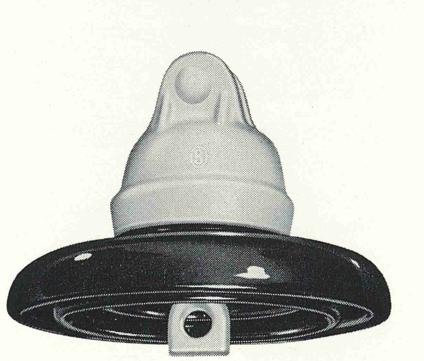
O-B's modern casting-manufacturing facilities assure accurate reproduction of all rounded corners and toroidal-shaped attachment holes for maximum benefit from O-B's patented yoke-design principles. Controlled distribution of metal permits selective placement of metal for high strength.



Analysis of your line specifications and characteristics enables the O-B-development engineer to select the correct O-B corona-controlled suspension clamp for your EHV-insulator-hardware system. Here's an example of the inherent flexibility in O-B suspension clamps to accommodate your minimum and maximum take-off angles.

Balanced electrical characteristics, regulated application of compressive stress, and optimum recovery ability exist in all O-B suspension insulators -- inherited from over 63 million predecessors.



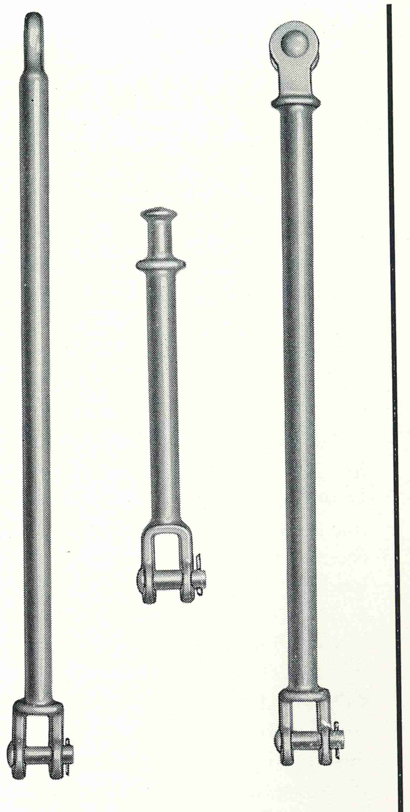
*(Continued from previous page)*

ment. At present, over 63-million O-B suspension insulators have been shipped from our Barberton, Ohio, facility. And, O-B offers a complete line of suspension insulators to support the numerous positions on a new EHV line -- 15,000-pound to 50,000-pound M & E rated units.

With selection of the correct O-B insulator and the quantity per string to support your new EHV insulator-hardware "system," your O-B development engineer selects the final component -- the upper-end linkage. O-B manufactures links in any combination of ball, clevis, and eye connections in lengths from 10 to 120 inches. You may connect to the tower any way you wish and maintain any spacing you desire. Your O-B development engineer checks your specifications, number of insulators required, then picks the linkage to do the job. Like all O-B hardware fittings, O-B links receive a hot-dip galvanized coating for assured long life and corrosion protection.

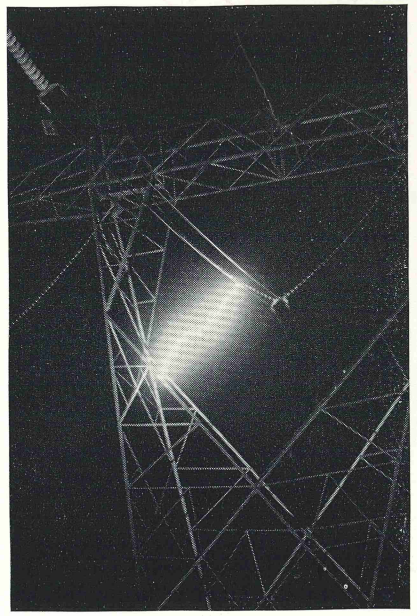
With all components selected and combined into a final form, the O-B engineer moves to the High Voltage Laboratory. Here, 60-cycle, impulse, RIV, and switching surge tests probe the electrical compatibility of the components, and the on-line performance of the insulator-hardware system. Mechanical performance and physical fit are also checked again. With all the performance requirements established to meet your specifications, the completed design is approved. Manufacturing begins -- all in O-B facilities -- then delivery to your line site. O-B ships your new insulator-hardware system in tower quantity packages, clearly marked for easy identification.

We've discussed the design, manufacture, and delivery of an O-B insulator-hardware *system,* and the benefits derived when you turn your specifications over to O-B for insulator-hardware development. If you have any questions, please contact your O-B district manager. He'll be glad to help -- and take your order.



O-B extension links are available with any combination of clevis, eye, or ball connections, in lengths from 10 inches to 120 inches.

Thorough 60-cycle impulse RIV, and switching surge testing in the outdoor portion of O-B's High Voltage Laboratory gives detailed performance information before approval of the final insulator-hardware design.



## Two IEEE transaction papers describe EHV tower-insulation research

### Discussions result from full-scale tests in O-B high voltage laboratory

During the IEEE EHV-AC Transmission Conference in Richmond, Virginia, two technical papers were presented which analyzed EHV tower-insulation tests conducted in the outdoor area of the O-B High Voltage Laboratory. Transaction Paper TP 65-814, *Insulation Characteristics of 345-kv Transmission Lines* by H. R. Armstrong of The Detroit Edison Company and Charles J. Miller, Jr., of Ohio Brass Company, examines the insulation characteristics of various combinations of vertical insulator strings in relation to tower proximity on 345-kv transmission lines. The primary objective of the series of tests leading to this new paper was to achieve minimum tower dimensions for a given insulator string length by correlation of string and air gap flashovers.

IEEE Transaction Paper TP 65-815, *Full-Scale Tower-Insulation Tests For APS 500-kv System* by W. C. Guyker of West Penn Power Company, A. R. Hileman of Westinghouse Electric Company and John F. Wittibschlager of Ohio Brass Company, discusses 60-cycle and switching surge tests conducted on a full-scale tower specimen to prove design data on insulator string length and tower striking distances for 500 kv. Design criteria derived from the APS tower tests established the insulator string length at twenty-four 5¾ x 10-inch units for each leg of the V-string. Minimum striking distance from the line to the tower side proved to be 11 feet 2 inches, while the minimum vertical striking distance to the tower top measured 12 feet 10 inches.

During both series of EHV tower tests, the co-authors made extensive use of the all-weather 4-million volt surge generator and 60-cycle equipment available in the outdoor portion of the O-B High Voltage Laboratory. For copies of the new IEEE transaction papers, ask your O-B district manager, or write to Ohio Brass Company, 380 North Main Street, Mansfield, Ohio 44902.



# Multirester's threaded base mounting simplifies arrester installations on distribution transformers

THOREX® MULTIRESTER

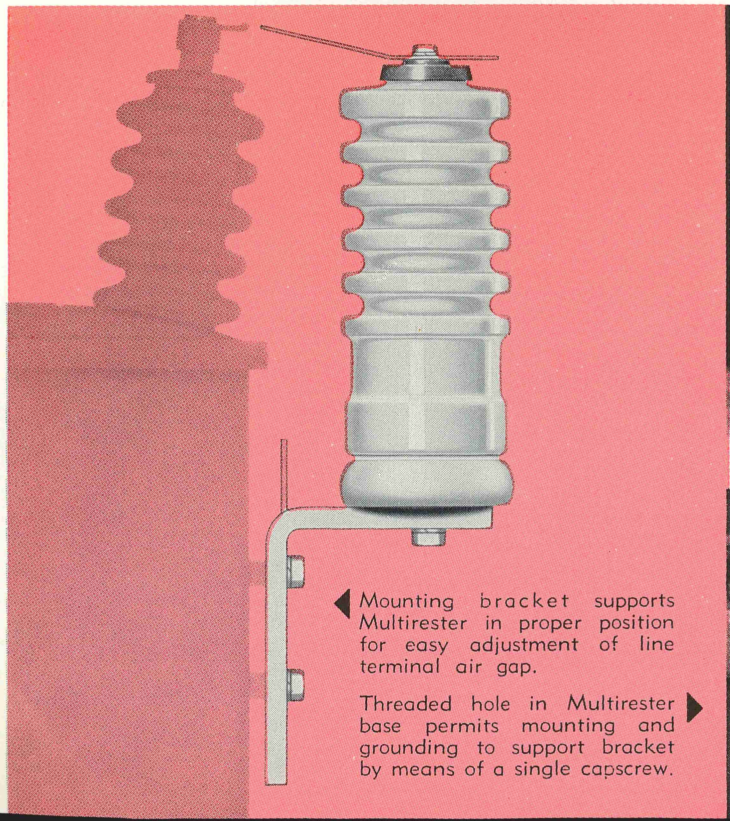
## Saves Time - Lowers Cost - Improves Appearance

Most convenient feature of O-B's Multirester for distribution transformer installations is the ⅝" - 11 UNC threaded hole in its malleable iron base. All Multiresters in ratings from 3 through 37 kv are furnished with identical base construction, greatly facilitating mounting and grounding provisions, and completely eliminating the need for special clamping bands and grounding straps. Installation simply consists of attaching a suitable metal bracket on the exterior of the transformer tank and then mounting the Multirester on this support by means of a single capscrew. Multiresters are available in either Skytone or brown glaze to match transformer bushings.

Mounting details of a typical Multirester installation on a conventional distribution transformer are shown in the illustrations below. The only critical dimension is that of the air gap which isolates the arrester from the line terminal of the transformer. This air gap can be accurately spaced by simply bending the heavy gage stainless steel wire loop which serves as the adjustable gap electrode.

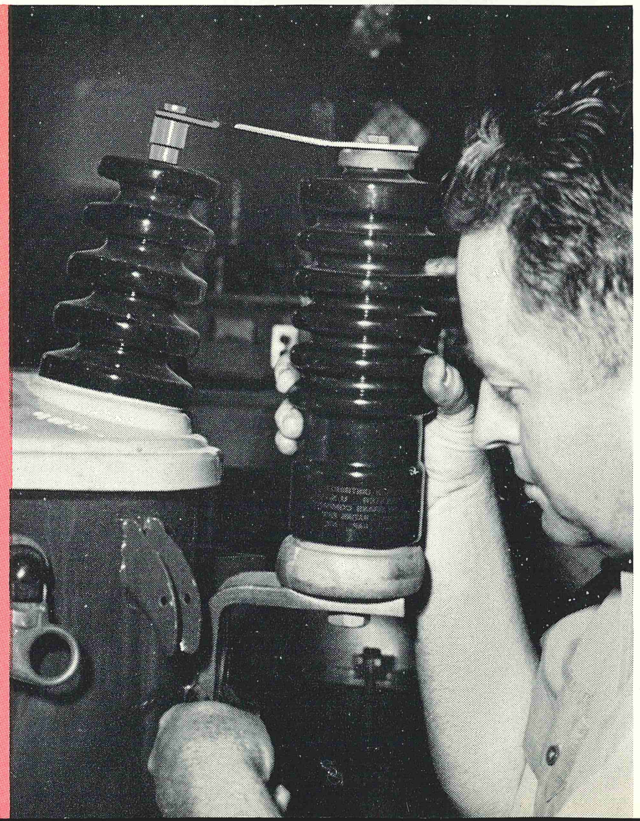
Selection of a suitable mounting bracket to position the arrester at approximately the same level as the transformer bushing depends on the location of available mounting lugs on the side of the transformer tank. Since considerable variation exists among transformers of different sizes and manufacture, arrester applications can be facilitated by use of special O-B brackets having slotted mounting holes. Long and short brackets are available with a total adjustment span of 18¾ inches, sufficient to accommodate practically all changeovers. Brackets can be ordered separately or in change over kit combinations with suitable capscrews and wire electrode as described in O-B's Multirester Catalog 43.

The improved lightning protection provided by Multirester equipment can often be obtained with an actual reduction in total cost. Significant savings are realized through the simplicity with which the lowest-priced standard base mounting Multirester can be adapted to transformer applications without requiring any line or ground terminal accessories except the stainless steel wire loop which serves as the air gap electrode.



◀ Mounting bracket supports Multirester in proper position for easy adjustment of line terminal air gap.

Threaded hole in Multirester base permits mounting and grounding to support bracket by means of a single capscrew. ▶



# Horizontal capacitors increase single stack potential

## O-B flat capacitor equipment racks simplify high voltage installation at Arkansas Power & Light Company substation

The unique horizontal arrangement of Mark IV 100 kvar capacitors in O-B's new "flat" equipments is especially adaptable to the functional planning of high-voltage substation banks. Principal advantage is that five of the flat capacitor racks can be installed in a single vertical stack no higher than that formed by three racks of conventional design. Series connection of dual-bus flat equipments permits construction of three-phase banks in just three stacks for operation at system voltages as high as 230 kv. A flat design equipment is only 36 inches high compared to the 62 inches required by racks with vertically mounted capacitors.

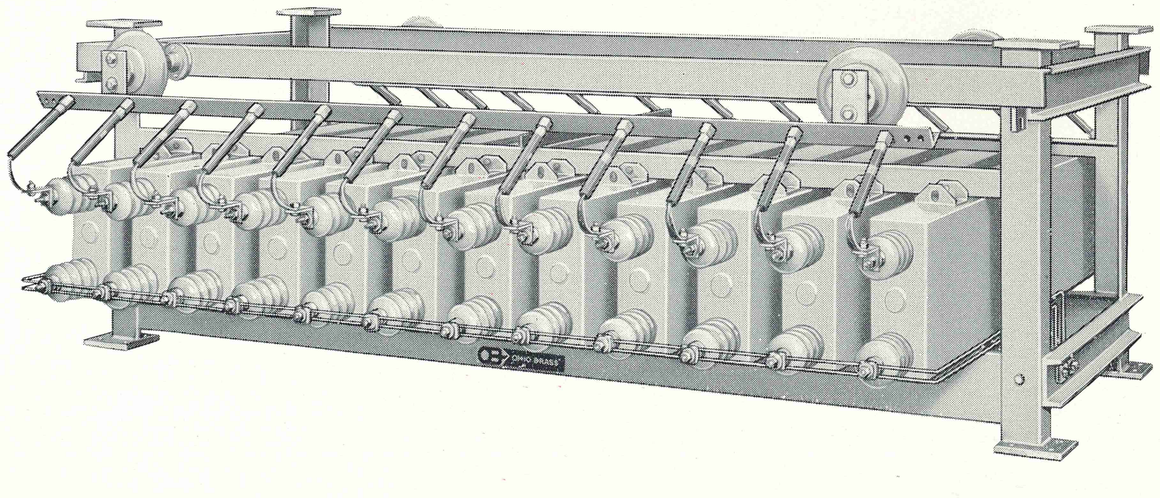
The three-phase grounded wye bank at Arkansas Power & Light Company's Oceola Substation exemplifies the specific benefits of the Mark IV flat equipments in high-voltage applications. Present operating level at this station is 115 kv, which requires that each phase of the capacitor bank has five series sections. As illustrated in the installation photographs, this has been accomplished by stacking three flat racks with dual-bus connection to form each single-phase stack. The arrangement supplies 15,000 kvar three phase to the system.

Installation of the flat design capacitor racks at the Oceola substation is particularly significant because engineering plans are underway to convert this station to an operating voltage of 161 kv. When the changeover occurs, it will not be necessary to locate and install additional capacitor stacks. Operating voltage of the existing bank can be raised by simply increasing the height of each stack by one more flat rack equipment and expanding the series connection to provide the seven sections required. Base insulators have been supplied and installed for the 161-kv ultimate rating. Kvar supply to the system will then be increased to 21,000.

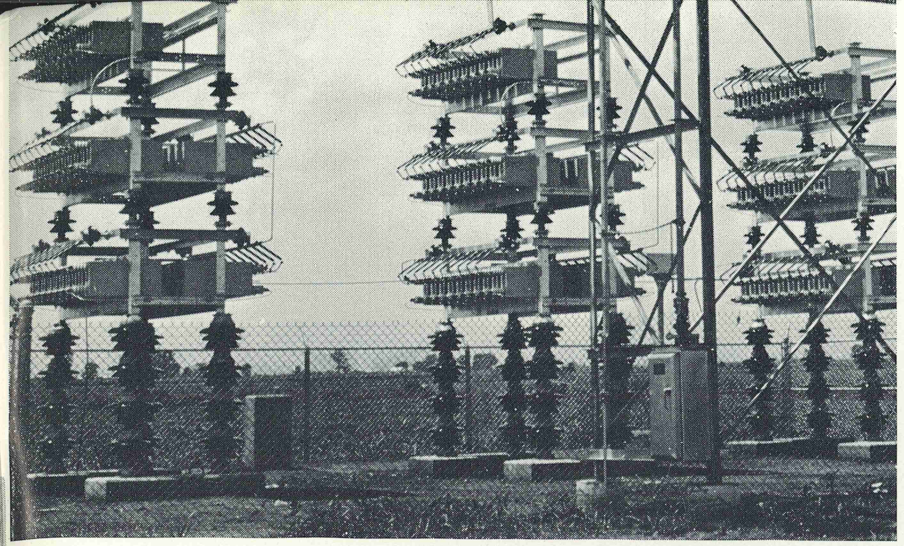
The horizontal mounting of the individual capacitors in the flat racks simplifies maintenance of the expulsion fuses and fuse links, and provides easier access to the capacitor terminals and connections. The arrangement also provides the inherent advantage of maximum separation of the energized conductors of dual-bus racks.

All Mark IV capacitors supplied in the flat equipments furnished for Arkansas Power & Light's Oceola Substation are of modern light grey Skytone color.

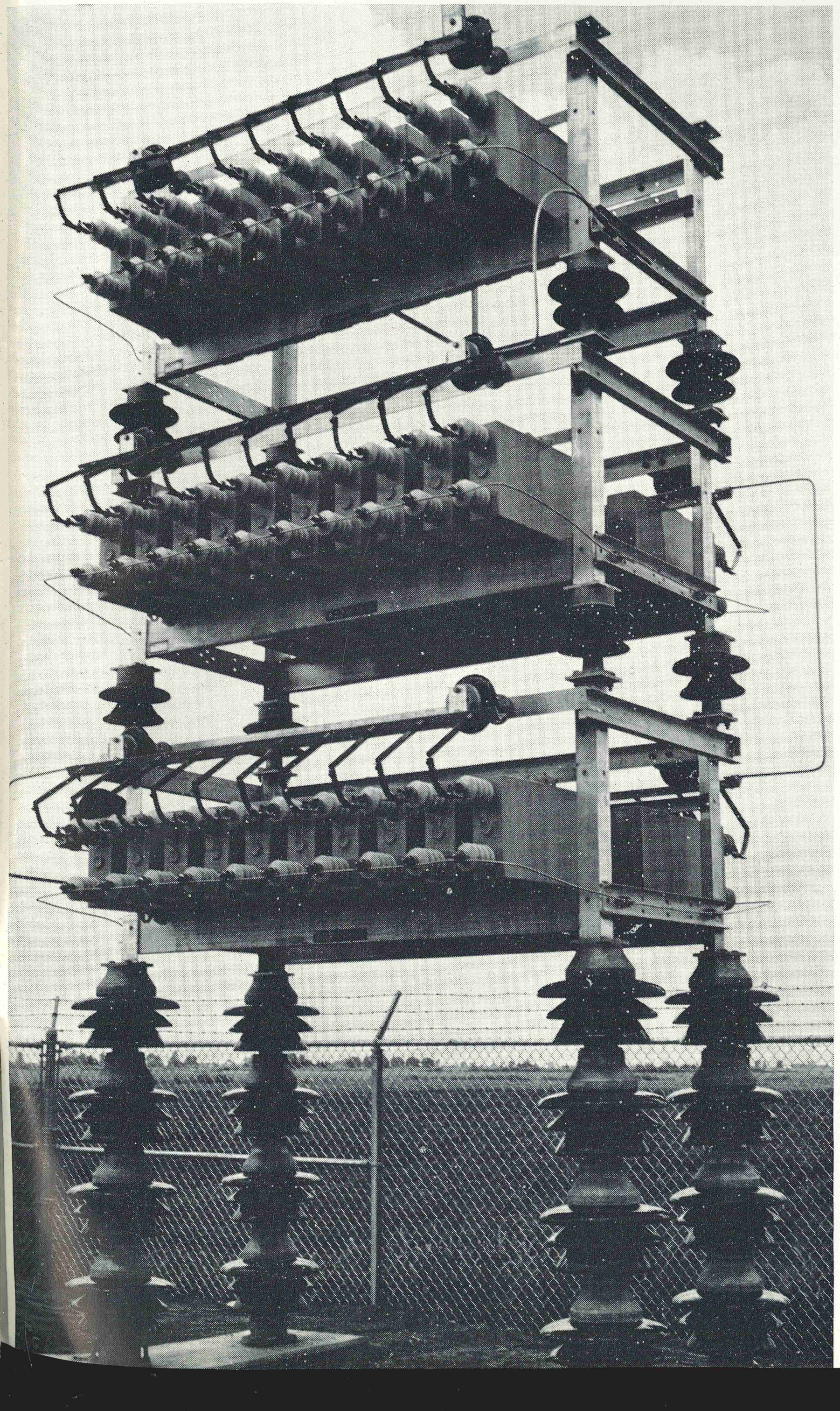
Principal advantage of O-B's new flat rack is reduced height. In high voltage applications a bank of three stacks of the flat equipments can supply the same kvar as a bank with six stacks of conventional design racks.





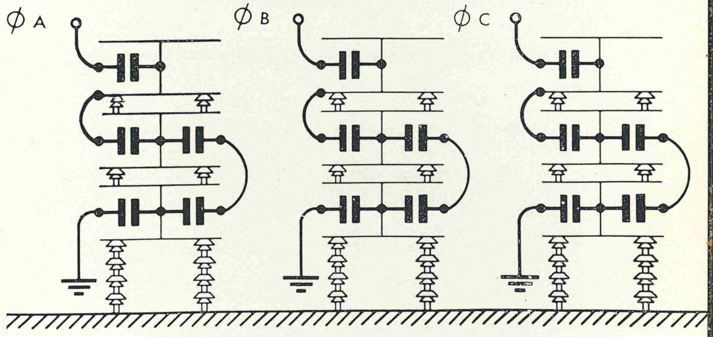


Three-stack, 115-kv Varex Mark IV capacitor bank installed by Arkansas Power & Light Company will eventually be converted to 161-kv by simply mounting an additional equipment on each stack.



Unique horizontal arrangement of capacitors permits single stack construction for voltages up to 230 kv.

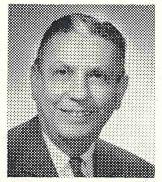
Schematic diagram of Arkansas P & L 115-kv capacitor bank illustrates method by which five series sections are provided for each phase of the grounded wye circuit.



**OHIO BRASS MANAGEMENT REPORT**

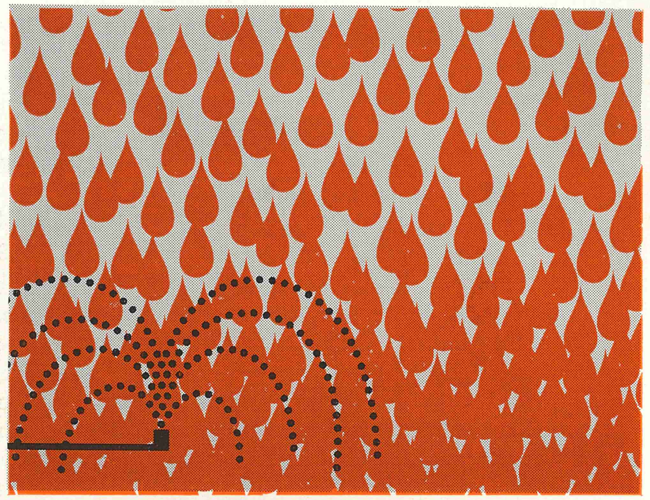
# "Soak, don't sprinkle" to grow improved lines for EHV

**BY ROGER A. BLACK**
PRESIDENT, OHIO BRASS COMPANY



You probably get the same advice in your area when the lawn turns brown under the summer heat. "Soak, don't sprinkle," counsels the local newspaper's garden editor in discussing survival treatment for parched lawns. If you'll strain your imagination to take a mammoth step from your front yard to the High Voltage Laboratory yard of Ohio Brass, you'll find the same philosophy at work in a vastly different form.

**"SOAK, DON'T SPRINKLE"** describes the way O-B engineers approach the testing of designs for EHV lines. Consider, for example, the hundreds of test points, each representing the firing of a generator, that go into development of curves and other detailed data for a suggested insulator-hardware-tower configuration. The new 4000-kv generator fired 16,000 shots for just two full-scale tower tests in checking designs for a 500-kv system. And because of the generator's ability to perform in all kinds of weather, many shots took place in a driving rain . . . a completely literal application of the "soak" approach to an EHV problem.



**THE "SOAK" METHOD** calls for a variety of tools and the talent and experience to use them. For example, the O-B High Voltage Laboratory has five different surge generators, each a specialized machine for specialized problems. Oscilloscope measuring stations for each generator have been completely enclosed in metal cages and shielded to assure accurate readings. Power may even be generated inside the cage to eliminate outside influence when necessary.

**AND A LAST** but important consideration: Soaked into every new project is knowledge from Tidd in 1946 to Apple Grove in 1961, from Ontario-Hydro's 115-kv line in 1909 to Hydro-Quebec's 735-kv line in 1965 . . . and from the supplying of equipment for more than 10,000 miles of modern EHV line.

744-H

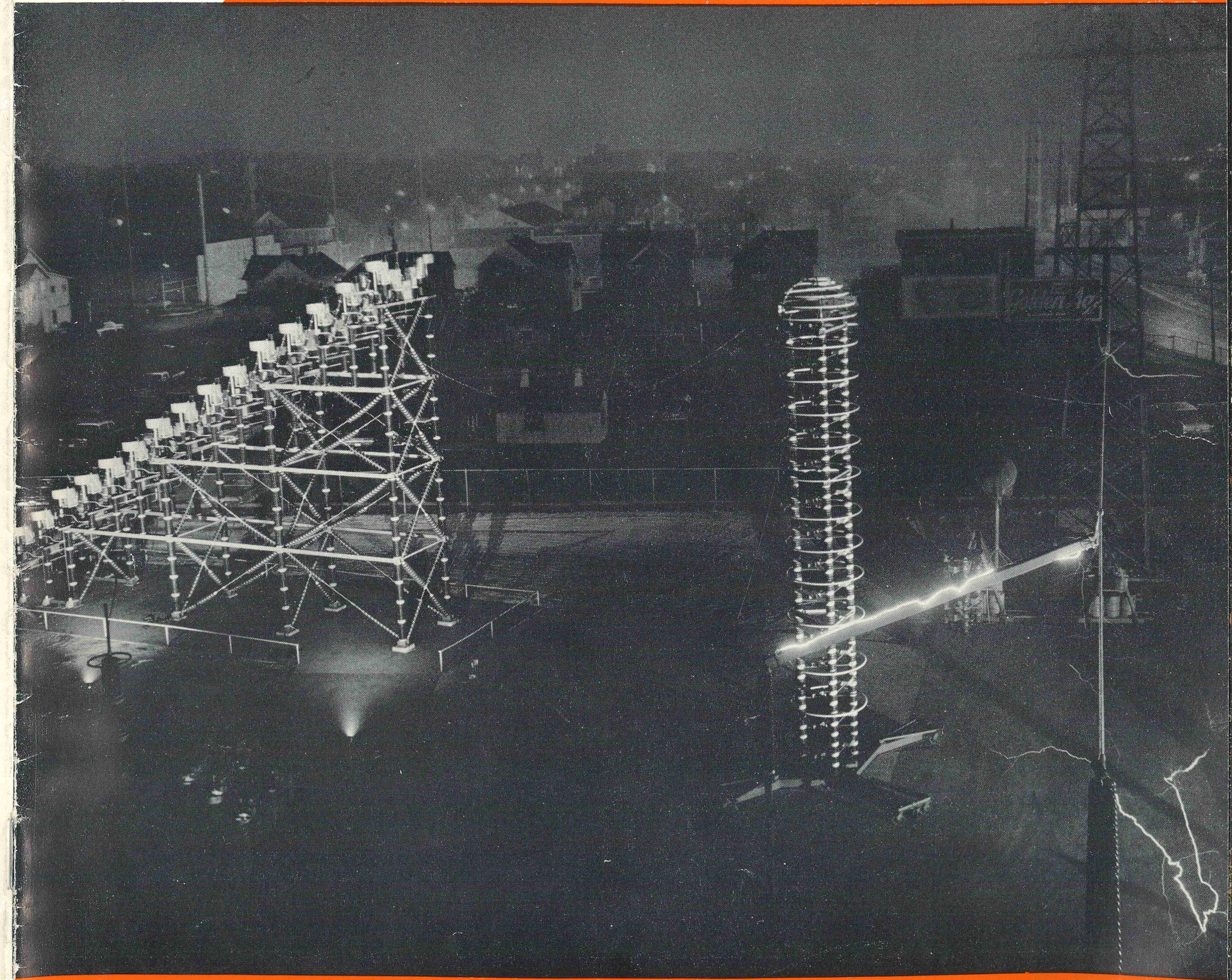
OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

6661-H Printed in U. S. A.

O-B Hi-Tension News

JANUARY 1966



**Special . . . on O-B's High-Voltage Laboratory**

# Real values of a laboratory will be found beneath the surface

Like an iceberg, only about one-ninth of the O-B High Voltage Laboratory operation shows. And, in the hidden eight-ninths lies the real distinction and vitality of this unique institution.

Obviously, technicians must have equipment with which to work. Because it is often large and complex, this apparatus is showy . . . perhaps even glamorous. But the only thing this equipment provides is cold data. Not only must these beautiful tools be reinforced by a host of unseen services, but the information they yield is no better than the brains that interpret it into something useful. Much goes on beneath the surface to accomplish these ends.

First, let us look into some of the facilities that augment various testing procedures that confront the laboratory. You might not expect to find within the laboratory building a fully equipped and full-time-manned machine shop. But it often happens that technical studies are directed toward the future, where new things to be tested don't yet exist. They first have to be made, or present designs modified. And even with all the technical equipment on the market, a genuinely creative organization working on the fringes of tomorrow seldom seems to find just what it wants. The machine shop, therefore, becomes a small manufacturing organization serving the laboratory.

An electronics shop, staffed with technicians and under the supervision of a graduate electronics engineer, is responsible for the design, manufacture, calibration, and maintenance of the many and varied controls and measuring instruments required by a modern laboratory.

Clear and accurate records are vital to a laboratory. Another integral department is a completely equipped full-time photographic facility. And in this same category, a trained librarian supervises the permanent files of test data that contain a wealth of experience.

Strolling through the byways of the laboratory one may discover certain niches set aside for long-time continuing studies; for example, hardware corrosion and lightning arrester sealing. Or we may go outdoors and find a fenced area where hundreds of different sizes, shapes, and even makes of insulators are living in the highly polluted atmosphere supplied by a neighboring chemical plant. Every specimen is energized and every one is connected to its own recording instrument to collect continuous data on long-time contamination leakage.

**January issue of Hi-Tension News provides detailed description of the advanced surge test facilities and procedures in daily operation at the O-B High Voltage Laboratory in Barberton, Ohio. Technical competences achieved in this laboratory contribute the essential factors of design confirmation to basic studies of EHV insulation systems, conductor and hardware performance and optimum tower construction. Known throughout the industry for authenticity of its full scale, all-weather outdoor testing, O-B's High Voltage Laboratory is a full-fledged participant in the NEMA-sponsored program to make testing facilities available on a cooperative basis.**

Next to this area is another where strings of suspension insulators are under constant load, in some cases for many years, to investigate strength characteristics.

These are only a few of probably hundreds of back-up operations that may not be immediately evident to the casual laboratory visitor . . . the eight-ninths of the iceberg that is under water, as it were. But in their total they tell of the breadth of laboratory facilities, and of the myriad of specialized functions that go toward making a truly competent research institution.

Even so, they are scarcely more than incidental to the real assets of the O-B High Voltage Laboratory; namely, people. Time after time, utilities that have used the laboratory for extensive EHV line studies have commented on the personal interest shown in their project and on the value of intimate contact with men of national reputation in the field of electrical research. A laboratory must be large to do the things presently expected of it, but this largeness has never been permitted to breed an impersonal or disinterested approach. Nor has it been allowed to create "ivory towers." An outdoor test may run throughout the night, perhaps in zero weather . . . an unpleasant prospect, but the path to right answers . . . and the power company engineer will find standing at his side, probably shivering with him, a recognized expert in the field.

The laboratory staff, engineers, director, and technicians alike, have no other interests or obligations. Naturally, because of the priceless experience it offers, young engineers pass through a training period on their way to executive posts in the O-B organization, but they are surrounded and guided by men of rich experience and background in all phases of the laboratory's operation. Of the four key men guiding research, for example, there is a total of 70 years' service.

In manpower, that overshadows spectacular equipment, the O-B High Voltage Laboratory can justly claim leadership in its branch of the electrical industry. And these men are never out of reach.

A further advantage, unique in institutions of its size, is singleness of purpose. The interests of this laboratory are confined exclusively to studies of power transmission and distribution.

In the following pages we will concentrate on the top one-ninth of the iceberg . . . the equipment and what it does. Most of the discussion will relate to surge or impulse testing since this is such a large and fascinating subject. To avoid confusion, it should be understood that the O-B High Voltage Laboratory operates five completely independent surge generators, each having certain specific specialties. Briefly, these would be described as:

(1) Small 1.5-million-volt generator . . . For routine quality control tests to establish manufacturing standards and to conduct limited product research.

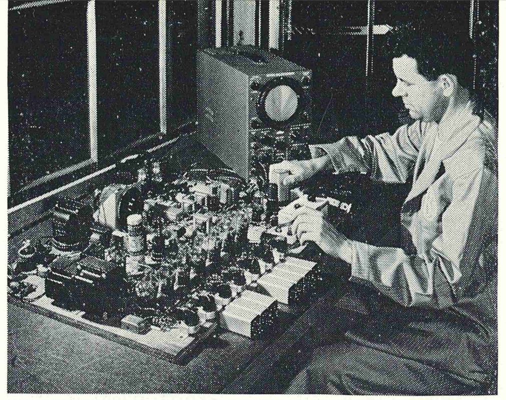
(2) Low-current, long-duration generator . . . To test lightning arrester components under realistic equivalents of long, highly charged transmission circuits.

(3) High-current, short-duration generator . . . To apply simulated lightning currents as high as 150,000 amperes to production and experimental models of lightning arresters.

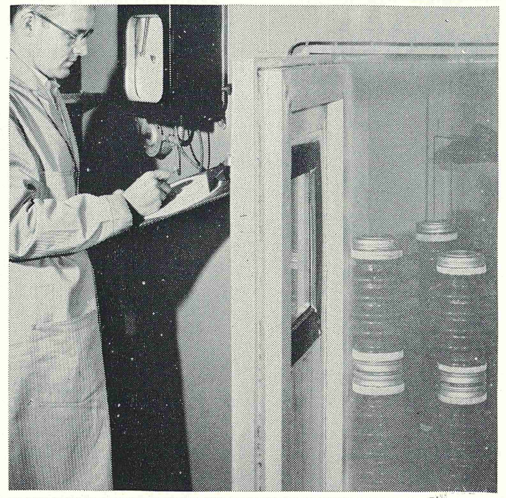
(4) Surge generator for 3-million volts . . . Typified by extreme flexibility in its output waves and by its ability to produce ultra-steep fronts as rapid as a rate of 7-million volts per microsecond.

(5) New 4-million-volt, 187.5-kilojoule surge generator . . . Primarily for the production of high-voltage switching surge and lightning impulse waves in testing full-scale tower-insulator combinations. Notable for its outdoor location and all-weather operation.

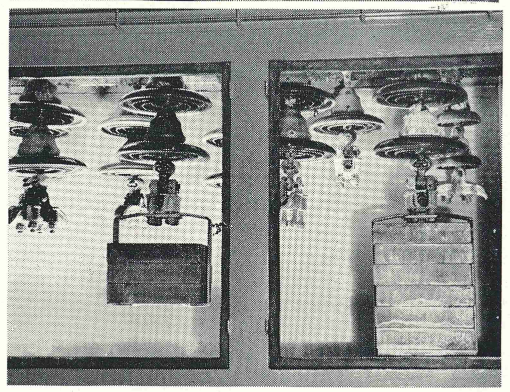
Instead of satisfying your curiosity, we hope the following description will merely stimulate a desire to visit the O-B High Voltage Laboratory.



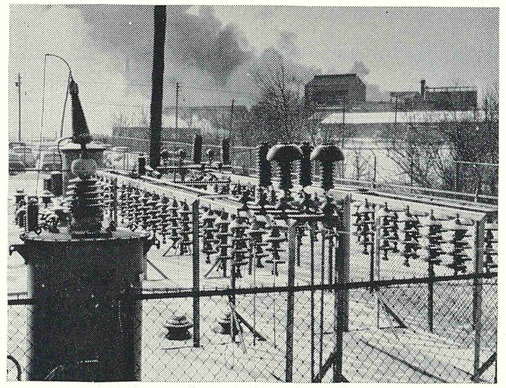
Prior to building a new piece of equipment, an Electronics Laboratory technician checks the circuit on a "bread-board" model. This department of the main laboratory produces many special instruments used in the laboratory and factory for testing.



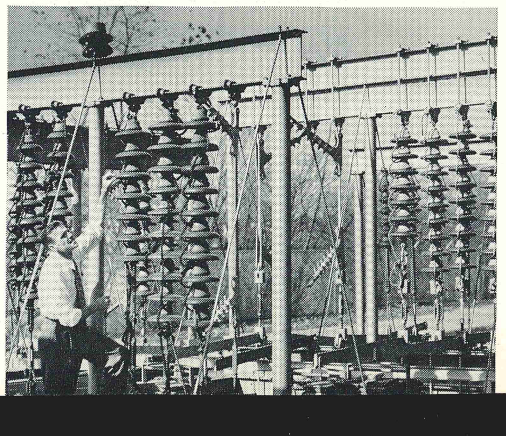
In one of the lower hallways of the laboratory, this heat and humidity test runs continuously to explore the long-time soundness of lightning arrester seals.



In another spare corner of the laboratory building, insulators and hardware are exposed to severe atmospheric chemical attack in a study of various metal coatings.



A section of the contamination test yard. In the background will be seen our copious and free source of air-borne industrial wastes.



For years, in many cases, insulator strings undergo various degrees of mechanical loading in the course of investigating strength and recovery characteristics. Intertwined ropes merely restrain the string, in case of breakage, so it will not damage the adjacent specimen.

OB Hi-Tension News
JAN. 1966, VOL. 35, NO. 1

**ON THE COVER** - Four-million-volt surge generator functions in conjunction with capacitance voltage divider to produce a spectacular 23-foot switching surge sparkover during routine tests conducted after dark at O-B's High Voltage Laboratory.

OHIO BRASS CO., MANSFIELD OHIO

# Five surge generators contribute flexibility and specialization to impulse testing

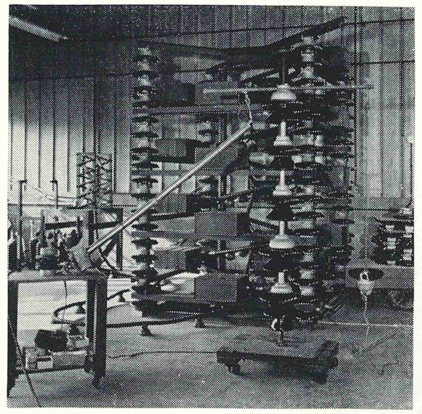
Surge or impulse testing occupies more and more of a modern laboratory's time. Once, this class of testing was rare, both in the need for it and in the equipment to perform it. Today it is an integral part of factory routine inspection standards, a constant companion of the development engineer, a tool for advanced basic research, and a mainstay of investigations into transmission phenomena.

One surge generator would be overwhelmed with demands. It would either be needlessly large or seriously inadequate for the variety of requirements. And it would be impractical to impart to only one unit the great range of characteristics now expected.

For such reasons O-B at present operates five complete surge generators in its High Voltage Laboratory . . . complete in power supply, control, and advanced instrumentation. They can all run simultaneously, and often do. Some are highly specialized. Others are graduated in magnitude of output so that smaller equipment can relieve the testing load on larger.

Please join us in this brief inspection tour of O-B's five surge generators.

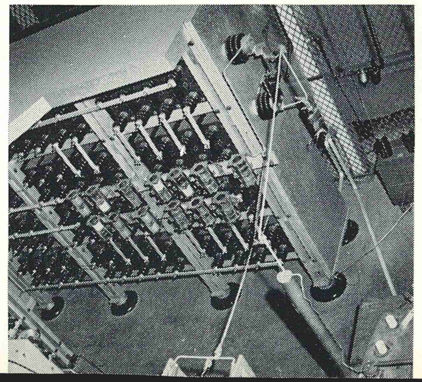
First we introduce the "baby" of the O-B surge generator family. Its output is seldom pushed beyond 1-million volts. It is handy and quick to work with. It occupies its own private section of the laboratory, away from all distractions. It fires away, day after day, and often night after night, on the routine testing of products for factory quality control. Value of this generator is gauged not only by the important work it does, but also by the relief it provides for larger research equipment.



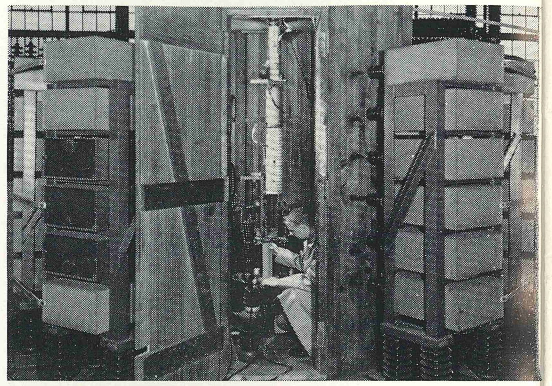
Quality control generator.

Switching-surge protection is one of the prime functions of a lightning arrester on modern EHV transmission lines. To evaluate arrester performance it is necessary to establish the exact electrical equivalent of several hundred miles of highly charged circuit. This specialized generator can be adjusted to simulate the characteristics of a given transmission line and then apply realistic surge testing to arrester components under such conditions. Special operating personnel are assigned to this generator so that it can run continuously on daily checks of factory output and investigations of experimental designs. Even if months of testing time could be made available, it would be difficult to modify a regular impulse generator to produce the necessary special wave forms; therefore, this entire category of testing is assigned to independent equipment.

Low-current, long-duration generator.



Almost the opposite of the switching surge generator for lightning arrester tests is this short-duration, high-current equipment for applying gross lightning currents to arrester components. Output of this apparatus can reach as high as 150,000 amperes for a few microseconds . . . equivalent to the most severe lightning stroke. Because the discharge is highly destructive and often produces failures of explosive violence, the test stand is enclosed in a heavy housing. This also muffles its ear-shattering noise. Here is another highly specialized surge generator that broadens the technical scope of the O-B High Voltage Laboratory and releases more versatile equipment for the study of transmission line phenomena.



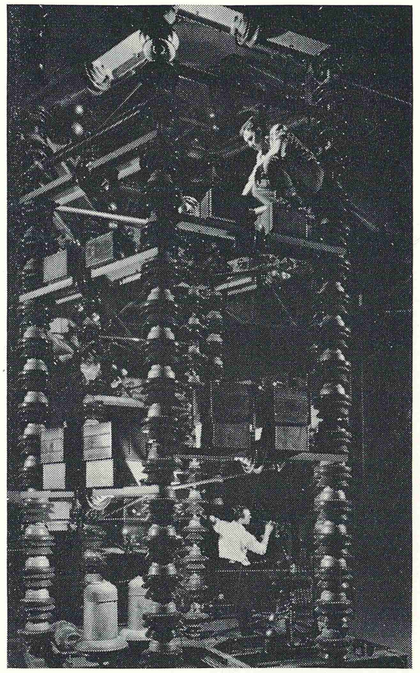
High-current, short-duration generator.

We now arrive at the first piece of full-time research surge equipment, the 3 - million - volt generator assigned to major product investigations and to full-scale transmission line studies. The unique compact design of this apparatus permits relatively quick adaptation to ultra-steep-wave discharges with rates of rise as fast as 7-million volts per microsecond . . . four to five times the speed of natural lightning and of inestimable value in advance research. The generator moves on tracks and may be moved either to the outdoor section of the laboratory or to the indoor test floor.

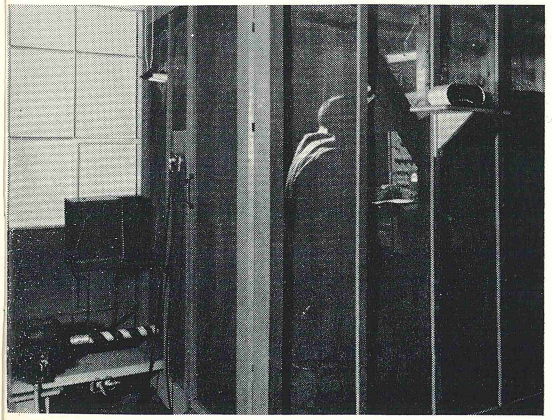
A counterpart of this generator is an "electrically sterile" oscilloscope room. In order to present the 'scope with a pure signal, free from extraneous interference, this totally isolated room was constructed. It stands well above the floor on insulators. For complete shielding, its platform is sheet copper and its walls and ceiling are double thicknesses of copper screening, all solidly bonded. To obviate the need for 120-

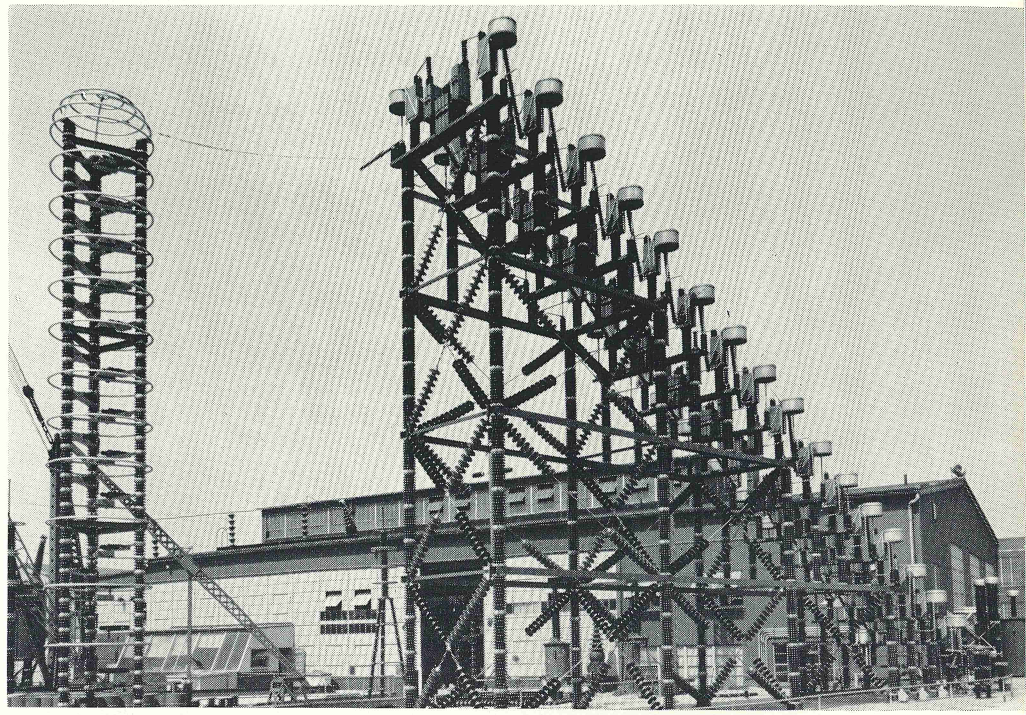


volt leads from the outside to operate lights and equipment, a small a-c generator within the room is driven from an externally mounted motor, connected by a long insulated shaft. Synchronization with the surge generator is obtained by a pulse of light shining through the screen, actuating a light-sensitive cell. Communication with the test floor is by means of an externally mounted intercom. The only electrical input entering the screen room is a triple-shielded coaxial cable connecting the voltage divider to the cathode ray oscilloscope. From this elaborate protected room come oscillograms of high quality, free from spurious signals. This facility is available to other impulse test equipment, when needed.



3-million-volt research generator.

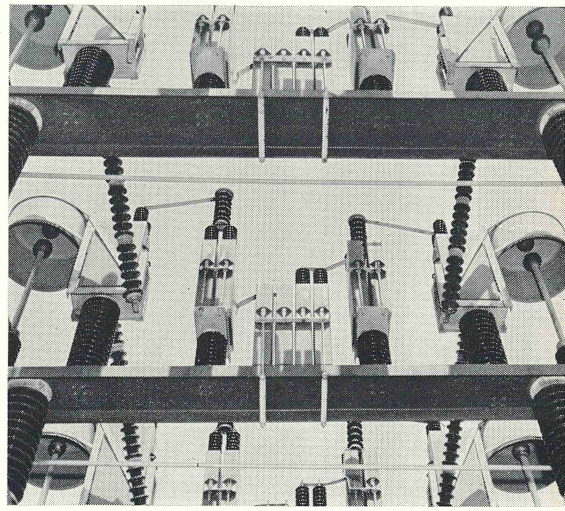




4-million-volt outdoor generator.

At the end of our trip we arrive at O-B's newest and largest surge generator, capable of a 4-million-volt output and designed to go to 6-million volts if ever needed. In many respects, this is a notable machine. It has the remarkable discharge capacity of 187,500 watt-seconds which, when resolved to a few microseconds, becomes an almost astronomical amount of power. It is adjustable to produce the extremely long waves typical of switching surges on EHV lines, at the full elevated voltages of these surges. Most unique is the fact that the generator is built outdoors, fully exposed, and will operate in any kind of inclement weather. To accomplish this, the multiple gaps of its Marx Circuit are shrouded to give full protection against rain, snow, or other air-borne materials that would otherwise trigger a gap and abort the discharge. Being outdoors, size and space are no factors and permit the mounting of 192 special high-duty capacitors on its 16 stages. At present, this is one of the industry's most sophisticated surge generators, backed by advanced control and elaborate instrumentation.

Related to this 187.5 kilojoule equipment is a 50-foot-high capacitance voltage divider for precise surge measurements and to provide wave front control in the production of switching-surge



waves. This additional divider also makes possible the combination of the 3-million-volt and 4-million-volt equipment to produce simultaneous opposite-polarity switching-surge tests, recorded on two separate oscilloscopes synchronized through a common sweep tripping pulse.

With this elaborate outdoor equipment it is now possible to do routine testing, in a natural environment, of full-scale lines and structures . . . obtaining completely realistic data.

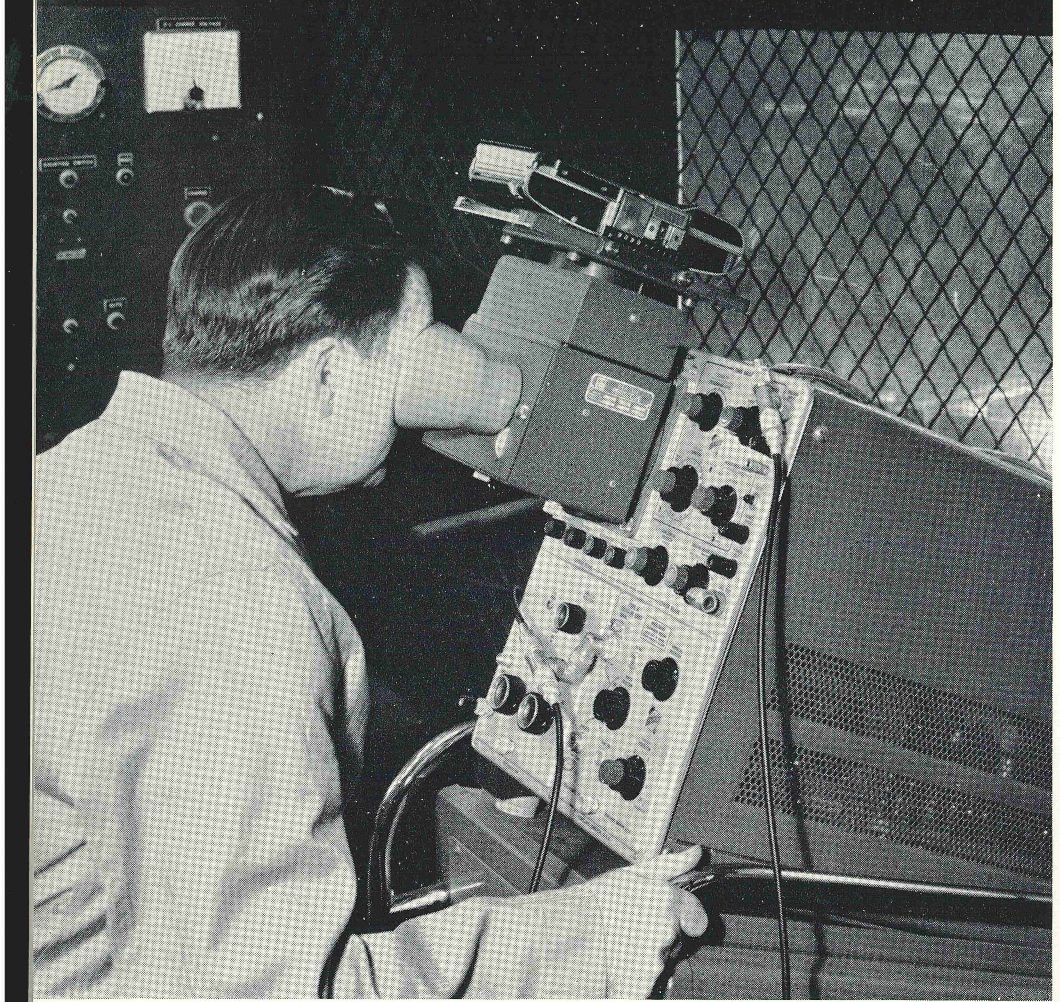


**Figure 1** - The precisely scaled image of the surge wave form reproduced on the oscillograph screen can be simultaneously viewed and photographed for further analysis.

# Multiplicity of surge wave forms demonstrate O-B's competence in testing

The language of O-B's High Voltage Laboratory involves numerous references to an impressive range of surge wave forms. These technical references reflect the progress achieved in O-B's laboratory in conjunction with performance tests on EHV equipment. Recognition of the more common surge test wave forms is particularly helpful in evaluating the capabilities and functions of the laboratory's surge generators in establishing insulation and protective levels for advanced system planning.

Wave forms are the graphical representation of voltage stress or current applied to a test specimen as referred to a time basis. Precise knowledge of the voltage wave forms provides such information as wave-front rate of rise, crest magnitude, time to crest, time to half crest, unidirectional or oscillatory properties. Exact wave forms of individual test surges can be viewed and recorded by specially adapted cathode ray oscillographs as shown in Figure 1.

O-B's laboratory capabilities for generating and measuring surges with wave characteristics specifically adapted to lightning and EHV insulation testing are acknowledged as accomplishments of the first order. At one end of the surge spectrum, impulse waves with voltage fronts rising four to five times as fast as natural lightning are a common test procedure. The voltage front of the steep wave illustrated in Figure 2 indicates a rate of rise of 7000 kv per microsecond, as compared to the 1000-2000 kv per microsecond normally associated with lightning.

At the other end of the surge spectrum, the wave form illustrated in Figure 6 is the slowly rising trace of a switching surge discharge of an EHV transmission line, produced by a surge generator which simulates existing line characteristics.

Historically, the impulse tests universally accepted in evaluating insulation characteristics in respect to lightning performance are based on the 1½ x 40 microsecond test wave shown in Figure 3. This terminology defines the test wave parameters as those in which the voltage rises from virtual zero to its crest value in 1½ microseconds and decays to ½ its crest value in 40 microseconds. Volt-time characteristic curves for practically all forms of line and station insulation are determined by repeated applications of this test wave, varying only the crest value from critical flashover to overvoltage flashover levels, as shown in the oscillograms of Figures 7 and 8.

Expansion of O-B laboratory facilities to include comprehensive switching surge testing has been of major significance in the coordination of EHV insulation and protective systems. System planning studies frequently indicate that severity of switching surges at voltage levels above 345 kv can be a limiting design factor. The characteristics of switching surges are known to include a huge family of wave shapes with relatively slow rising voltage fronts and wave tails of comparatively long duration. Assuming the 300 x 5000 microsecond wave shown in Figure 4 as a typical switching surge, it takes 200 times as long for its voltage to reach its crest value as in the standard 1½ x 40 impulse wave and 125 times as long for its wave tail to decay to half its crest value.

A further consideration applicable to the comparison of switching surges to overvoltages caused by lightning is that their slowly rising fronts are likely to start from some pre-existing voltage of opposite polarity which may be trapped on the transmission line. O-B conducted extensive studies of the effects of bias voltage factors on the severity of switching surges.

Current surge tests performed in the laboratory are also defined by reference to their wave forms. One common test procedure is the standard high - current, short - duration surge applied to arrester elements to ascertain the discharge voltages associated with lightning currents. A typical current surge generated in the laboratory for this purpose is shown in Figure 5 and is described as a 5.5 x 12.5 microsecond wave, with a crest value of 103,000 amperes. The oscillograph record also shows the wave form of the IR voltage produced by this current surge.

System designers have been particularly concerned with the durability of EHV lightning arresters in connection with anticipated long-duration, high-energy switching surges. Proof of thermal capacity under such circumstances has been provided by surge testing with a generator modeled to have the identical characteristics of any specific transmission line. The oscillograph shown in Figure 6 indicates the wave form of the surge discharge through a 276-kv arrester of a 280-mile 345-kv transmission line with 300-ohm impedance charged to 2.5 per unit of crest voltage.

Knowledgeable application of appropriate surge-test wave forms constitutes a measure of O-B's versatility and competence in laboratory research concerning insulation and protective systems. The reliability of results obtained attests to the specialized experience of the laboratory engineers and the unique test facilities which they have developed.

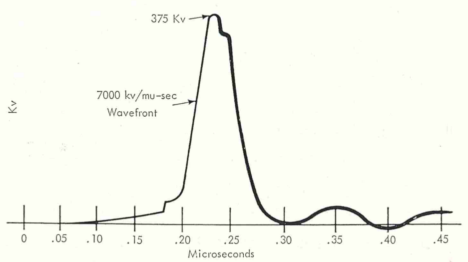



**Figure 2** - Steep front (7000 kv/mu sec) wave impulse.

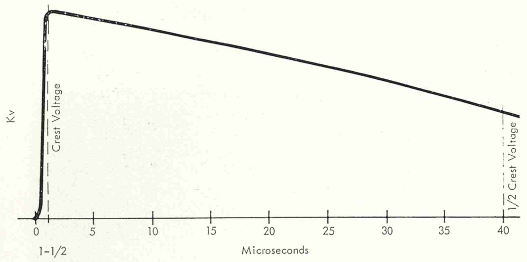



**Figure 3** - Standard 1½ x 40 mu-sec impulse test wave.

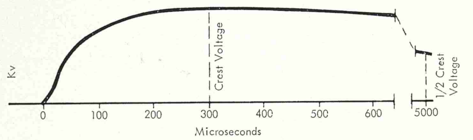



**Figure 4** - 300 x 5000 mu-sec switching surge wave form.

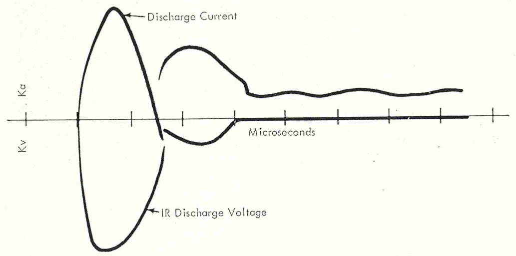



**Figure 5** - Wave forms of high-current, short-duration surge and associated IR discharge voltage.

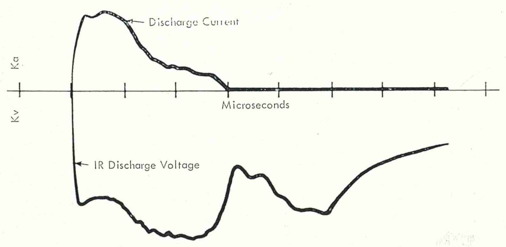



**Figure 6** - Surge waves produced in transmission line discharge tests.

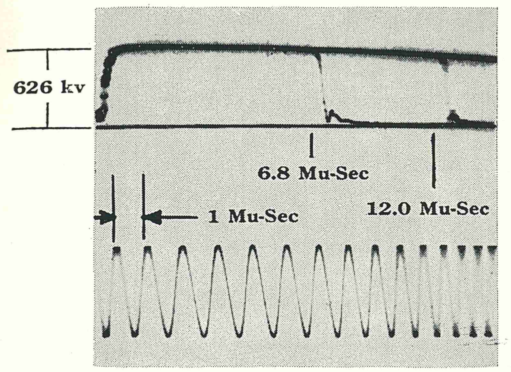



**Figure 7** - Critical flashover value is test voltage at which flashover of insulation occurs on half the surge applications.

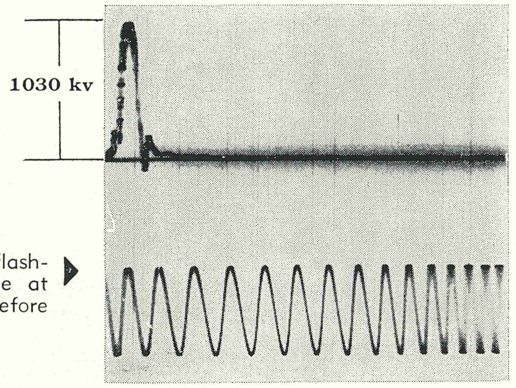



**Figure 8** - Front-of-wave flashover value is test voltage at which flashover occurs before wave crest is reached.

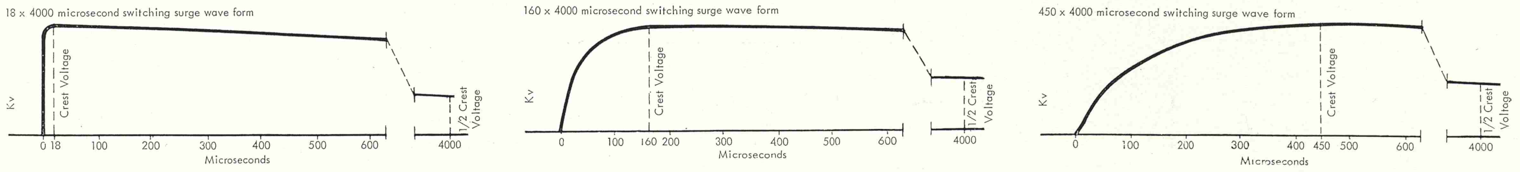
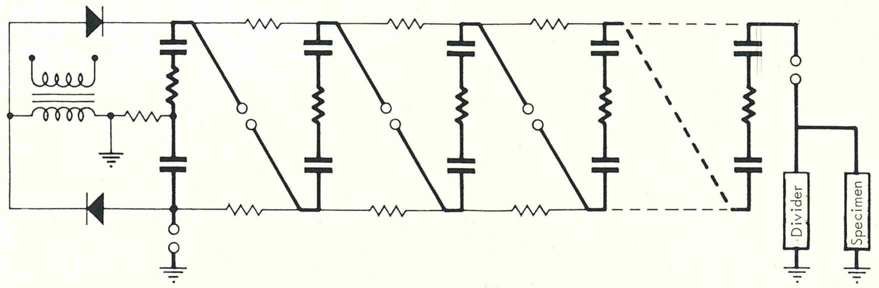



**Figure 9** - Series of typical wave forms produced in O-B's High Voltage Laboratory during an investigation of switching surge characteristics.

Figure 1 - Basic circuit for surge generator. Light lines indicate parallel connection by which capacitors are charged; heavy lines show series discharge path established by gap sparkovers.




# O-B's High Voltage Laboratory / Excels in generating and measuring high voltage surges

The complex surge test generators available to research engineers in O-B's High Voltage Laboratory are basically devices by which inherent insulation characteristics of electrical equipment can be accurately determined. Consequently, the engineers' principal evaluation of their capabilities center on the range of their flexibility in test wave generation, the stability of their operation, and the provisions available for precise measurement and recording of test results.

Unquestionably the most influential factor in the broad objective of obtaining authentic test results is O-B's background of laboratory technique and experience which serve to guide the installation and operation of this specialized test equipment, as well as the formulation of laboratory procedures by which its full potential can be manipulated and documented.

As an example, O-B's 4000-kv stairstep surge generator anticipated the utility industry's need for outdoor test facilities which could apply high-voltage surges ranging from the standard 1.5 x 40 microsecond impulse wave to switching-surge waves in the order of 150 x 5000 microseconds. The familiar Marx circuit, shown in Figure 1, provides the means by which the generator's capacitors are charged at a relatively low voltage while connected in a parallel circuit, then discharged at high voltage through the series circuit (shown by heavy lines) established by chain ignition of the spark gaps. In circuit diagrams Figures 2 and 3, the parallel charging arrangement has been omitted for the sake of clarity and the generator circuit is shown at the instant the spark gaps have fired.

The first of these two diagrams, Figure 2, indicates the test circuit arrangement applicable to the generation and measurement of 1.5 x 40 microsecond impulse-type surges. The rate of voltage rise, or steepness of the wave front, is controlled primarily by the resistance R1 existing in the series circuit of the generator at the instant the high-voltage discharge is initiated. The rate of voltage decay of the discharge, or the time to half crest value, is determined by the shunt resistance to ground, consisting of R2 and R3 in series.

The impulse voltage is simultaneously applied to the specimen and to the voltage divider consisting of the non-inductive, calibrated resistors R2 and R3 in series. A cathode ray oscillograph (CRO) connected across resistor R3 measures the voltage e. The test voltage E of the impulse is then calculated by using the equation:

$$E = e \left\{ \frac{R2 + R3}{R3} \right\}$$

Test waves with fronts as steep as 7,000 kv per microsecond, which may be four to five times as fast as those produced by natural lightning, have been used to test small distribution-type insulators. Such steep-front voltage waves are generated by reducing to a minimum the series resistance R1 in the surge generator.

The second discharge diagram, Figure 3, shows the test circuit used when the specimen is to be subjected to switching surges. When the surge generator discharges into the wave-forming network consisting of resistor R4 in series with the loading capacitor C1, a slow-front switching-surge-type wave is applied to the specimen. The tail of the switching-surge wave is controlled by the resistive circuit to ground provided by the charging resistors as shown in Figure 1. The loading capacitor C1, and the low voltage, high-capacitance capacitor C2, form a voltage divider for measuring the magnitude of the voltage wave. A cathode ray oscillograph (CRO) connected across capacitor C2 measures the voltage e. The test voltage value E of the switching surge is then calculated by using the equation:

$$E = e \left\{ \frac{C2 + C1}{C1} \right\}$$

The voltage e in Figures 2 and 3 is generally measured by means of an appropriate cathode ray oscillograph connected to the voltage divider by means of a suitable coaxial cable. The shape of the voltage wave and its magnitude, as a function of time, may be observed visually on the oscillograph screen and simultaneously may be recorded photographically as a permanent record of the test wave. Calibration lines having a deflection of known magnitude and appropriate timing waves are also recorded on each roll of film to provide the necessary magnitude and time calibrations for scaling the test wave oscillograms.

Figure 2 - Surge generator connected for impulse (1½ x 40 mu sec wave) testing. Voltage measurement is accomplished by means of the cathode ray oscillograph CRO and the resistive voltage divider R2 and R3.

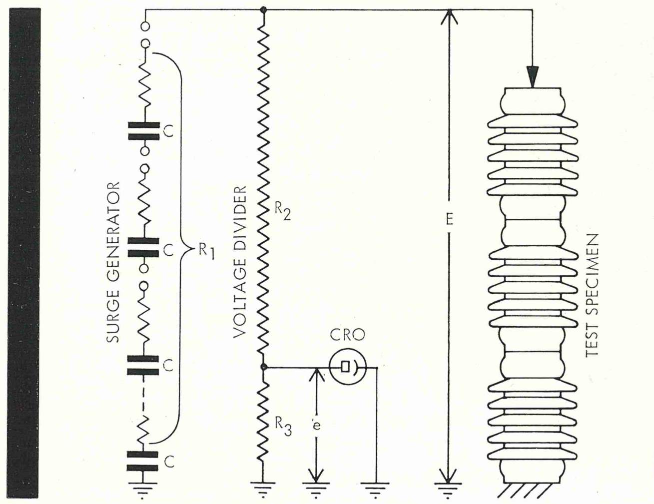



Figure 3 - Surge generator connected for switching surge testing. Wave-forming resistor R4 and loading capacitor C1 determine shape of wave front. Voltage measurement is accomplished by means of the CRO and the capacitive voltage divider C1 and C2.

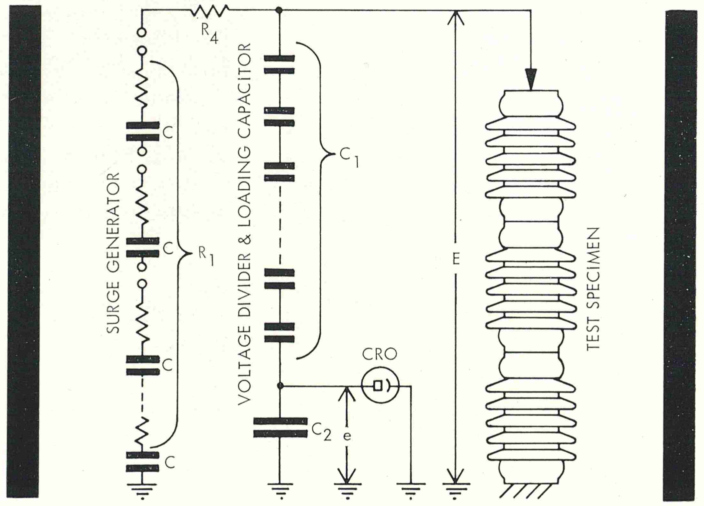


Figure 4 - Fifty-foot loading capacitor and voltage divider tower accommodates helical series circuit of 40 high-voltage capacitors used for switching surge testing up to 3200 kv.

# EHV system planners determine tower-insulation surge performance in O-B high voltage laboratory

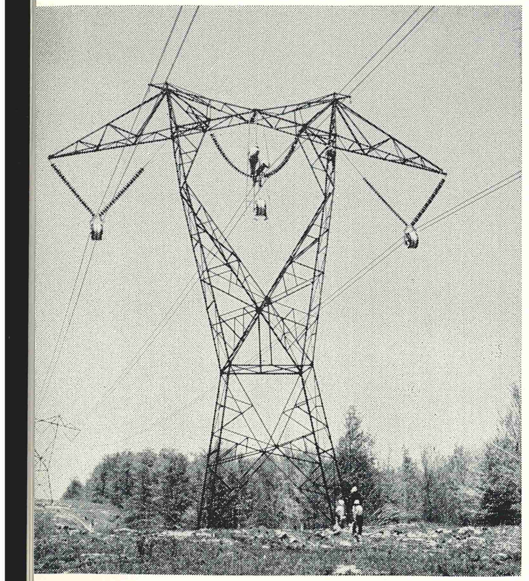
East, west, north, and south, EHV transmission towers keep springing up as construction progresses on the numerous new superhighways of power. Many of the new EHV towers and insulator-hardware assemblies trace their origin back to the O-B High Voltage Laboratory where detailed surge tests established final design dimensions. At least six EHV lines now under construction share this common development history -- including the first 500-kv system in the U. S.

Why did these EHV planners come to Ohio Brass to develop their tower design and surge specifications? One reason: the broad capability of the O-B High Voltage Laboratory. Here, the line developers were assured of accurate reproduction of the anticipated surges on their new line, plus the availability of all-weather outdoor surge-testing facilities. As an example of both qualities, one tower testing series required production of over 6,000 individual switching surges, with one full day's testing conducted during a natural rainstorm.

Surge testing tower designs requires a wide variety of tests. Each line developer has different basic problems relative to his environment, construction, and line route. With his tower strength requirements, bundle configuration, number of circuits per tower, and right-of-way limitations determined, the line designer develops a basic tower design. Then, by transient network analyzer studies, he determines the maximum per-unit switching-surge voltage and selects his switching-surge withstand voltage. With this information, the system planner moves into the outdoor area of the O-B High Voltage Laboratory to develop the most economic tower-insulation system that will give the required switching-surge withstand level.

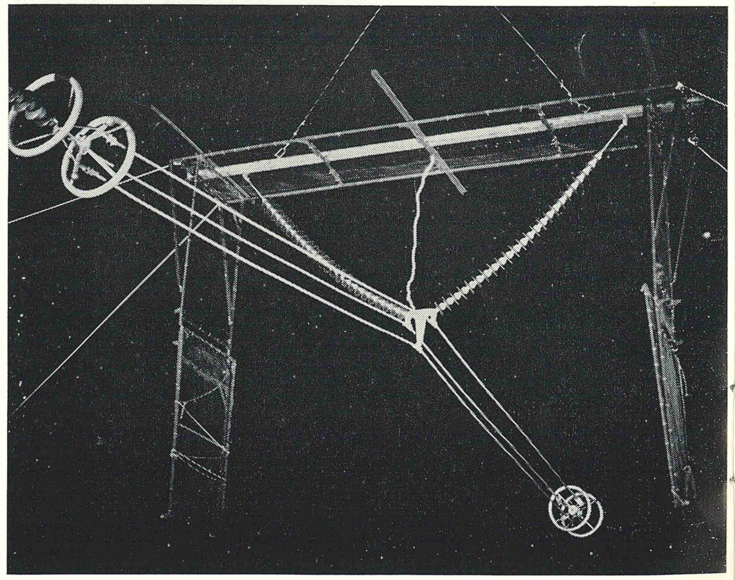
In the laboratory, O-B engineers assist with development of a test procedure which will furnish reliable data in the most efficient way. Initially, a simulated structure is constructed, employing the bundle-conductor assembly specified. A simulated outside or center phase is constructed with O-B's "flying window." The flexibility of the "flying window" permits adjustment of the critical tower crossarm and side clearances to aid development of the correct striking distances.

Testing begins with a series of multiple shots applied to the test specimen with either O-B's 3-million- or 4-million-volt surge generator. The magnitude and effect of each shot is recorded -- either withstand or flashover -- for construction of a flashover-voltage probability curve, while an oscilloscope duplicate of the applied wave shape is photographed for a permanent test record. Switching-surge voltage and wave characteristics remain constant for each shot in a series. Five 40-shot series may be run at different voltage levels. Each test series is plotted as one point on the flashover-probability curve.



Several new EHV towers received their preliminary and final design surge testing in the O-B High Voltage Laboratory, including the first 500-kv system in the United States.

Preliminary tower-insulation design tests use O-B's "flying window" to simulate the center or outside phases. Dimensions and configuration may be varied during testing to find the most economic tower size and shape for a new EHV line.





# Full-scale surge-testing facilities, all weather capability, flying window, and outdoor test yard permit detailed design testing

Extrapolation of the best-fit straight line through the test points into the low - flashover - probability region determines the withstand characteristics. Alteration of the test specimen's dimensions raises or lowers the withstand value until the required level is achieved.

Another variable in the development of the optimum tower-insulation design involves selection of the correct insulator string length. The effect of the number of insulators on flashover performance of a given tower-window configuration is determined by multiple tests. Results from these tests show the maximum practical number of insulators that can be used in any particular tower-window design.

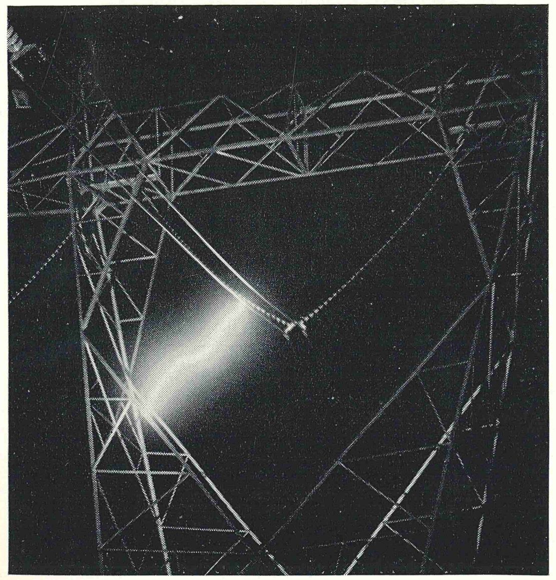
Many tower configurations and insulator-string combinations are examined during the rigorous test program, and the most efficient combination selected for further tests. Both positive and negative surges are impressed on the selected specimen in wet and dry conditions to check all possible operating conditions. Then, lightning impulse testing begins.

Impulse testing with a wave shape that duplicates the effect of lightning establishes the volt-time characteristics of the tower-insulator combination. Data derived from these tests can be used to establish the lightning performance of the transmission line. Conducting both switching-surge and lightning performance tests in the one facility saves development time and yields comparable data.

With the initial design tests completed, the line planners begin analyzing all the collected data and developing their basic tower design. After weeks of careful study and planning, it's back to the outdoor laboratory for more testing -- on a full-scale tower. The design tests are repeated on the actual tower assembly to prove the performance data derived on the simulated structure. With these examinations completed—and passed—the final tower design is approved.

Surge testing EHV transmission towers and insulation systems remains a specialized capability in the O-B High Voltage Laboratory. Both the 3-million- and 4-million-volt surge generators accurately reproduce specific wave shapes time after time, to furnish the control necessary during critical tower testing. O-B's 50-foot-high capacitance voltage divider aids in shaping the wave front and permits accurate measurement of switching surges. All-weather capability lets you test your design in realistic environments — even rain, sleet, and snow — and obtain reliable performance data.

If you're developing a new EHV transmission system, let O-B and its competent High Voltage Laboratory help you. Our equipment, facilities, and personnel are ready to work with you on development of your new line now. Just ask us.



Outdoors, a surge produces a gap flashover to the side of a full-scale tower erected in the test yard. Testing the full-scale final design proves the validity of your design criteria and gives you detailed performance information before construction.

In the control room, laboratory personnel regulate the discharges of the new 4-million-volt surge generator, record each discharge voltage, and photograph an oscilloscope reproduction of the wave shape for a permanent record.

# High voltage laboratory testing dictates the "preferred geometry" of suspension insulators

The first O-B suspension insulator was born of laboratory testing; the latest designs go back regularly for more. A. O. Austin, long-time O-B chief engineer and the father of the modern disc insulator, tested innumerable shapes and sizes to arrive at his 10-inch-diameter, 5-inch-section, prototype in 1909. It was large enough and strong enough to be rated 7,000 pounds and its geometry offered insulation qualities at least equivalent to the air which it would displace.

High Voltage Laboratory testing shaped the first insulator and has been the basis for improving its quality ever since. Sixty-cycle test voltages up to flashover were the only laboratory tool Austin originally had, but this was soon followed by laboratory ability to produce a surge impulse similar to a stroke of lightning, one natural test for all insulators.

When the original 5 by 10 design was returned to the laboratory for impulse testing to re-evaluate its performance, it was found to have a most efficient shape and size. If anything, it was determined that its characteristics were on the conservative side. Extensive impulse testing finally led to extending the section to 5¾ inches, and, with strengthened material, the O-B 15,000-pound suspension insulator evolved. The longer section, found practical through laboratory testing, maintained a desired insulation balance with the air around the insulator.

Laboratory surge testing next turned to exploring the effects of much steeper waves at higher voltages. Both impulse generators and laboratory techniques were improved. Repeated application of steep wave impulses revealed that leakage distance over the surface of the porcelain was the controlling design factor rather than size. For example, an increase of diameter and section length would not provide improved insulation qualities, but increasing the petticoat surface on the underside of the insulator improved its ability to withstand higher steep wave levels.

Higher transmission voltages of 345 kv and above have recently changed the emphasis of insulator testing from lightning impulse to switching-surge considerations. Air switching-surge flashover strength to withstand strength diminishes proportionally as voltages rise. The air space insulation allowed for good lightning performance in normal construction at lower voltages is sufficient, but the necessary space required at EHV levels becomes critical to the point where switching-surge insulation is the primary design factor. Imposed on this change in suspension insulator requirements are the further mechanical requirements for heavier loadings to carry bundled conductors.

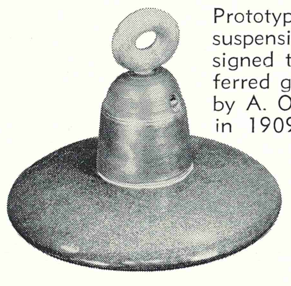
Back to the High Voltage Laboratory went O-B's insulator designers, this time to evaluate and consider requirements of both lightning and switching-surge withstand for a variety of mechanical strengths. The objective remained the same: an insulator design of optimized proportions which provided insulation equal to that of air. Considerations for testing were further enlarged by availability of higher strength designs. Thousands of comparative tests including steep wave wet and dry switching surge and lightning impulses proved that design optimums for lightning and switching surges were fundamentally the same. Exhaustive tests proved that selected designs could serve both requirements.

Higher mechanical strengths for heavier construction necessitated increasing insulator dimensions. The changes, however, could be accommodated to maintain optimum insulation balance. The O-B 36,000-pound insulator was increased to a 10½-inch porcelain diameter, but retained the 5¾-inch section length. The 50,000-pound suspension was designed with 11½-inch diameter and 6⅛-inch section length. "Preferred size" changed only to accommodate higher mechanical strengths. These size changes were laboratory tested at every point to keep the best possible balance of insulation commensurate with the necessary increase in dimensions. "Preferred geometry" is a matter of mechanical strength and insulation balance as determined by thousands of laboratory tests.

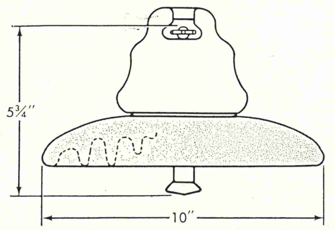
Just as the first O-B suspension insulator was built on laboratory data, the latest variation of the newest EHV design is likewise a result of continuing High Voltage Laboratory testing.

As much as suspension insulators may look alike, their differences are great, their common denominator is laboratory testing.

**5-inch section x 10-inch porcelain**



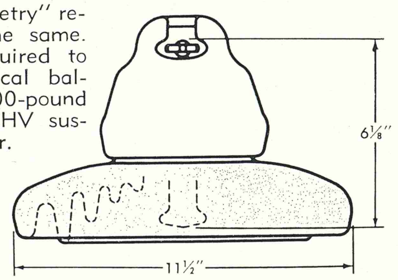
Prototype O-B suspension designed to "preferred geometry" by A. O. Austin in 1909.



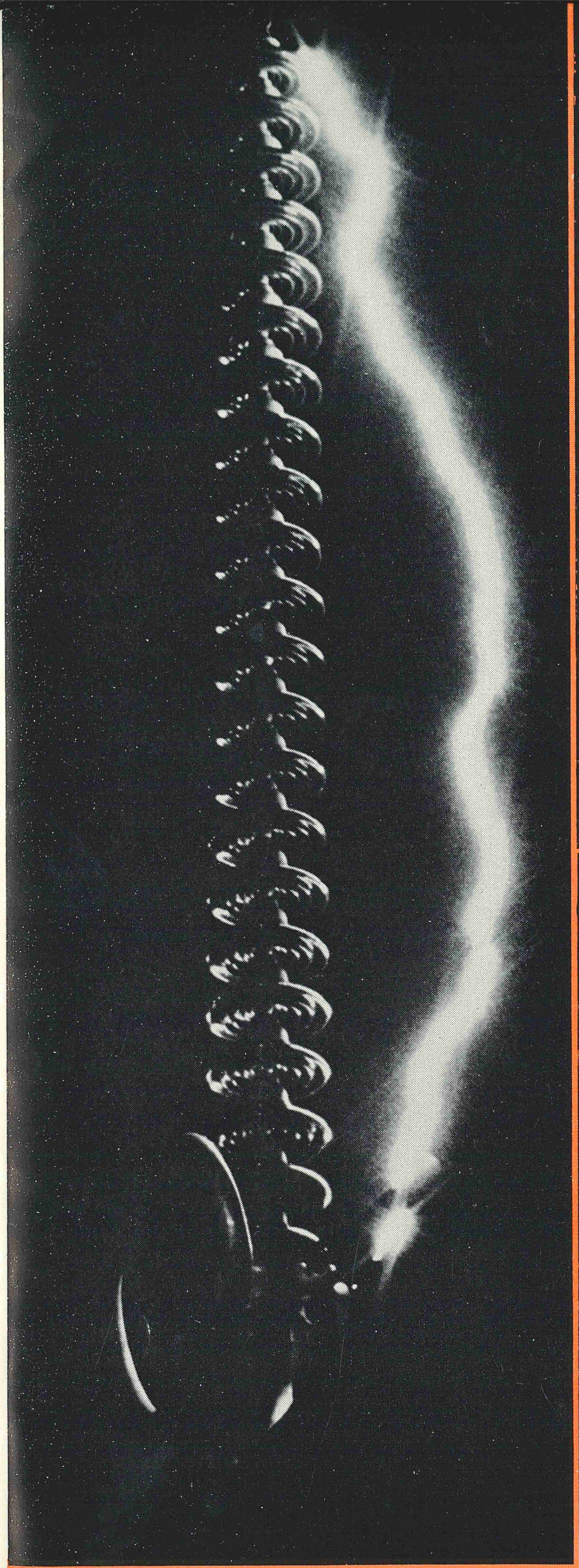

**5¾-inch section x 10-inch porcelain**
Modern O-B insulator was first developed by re-evaluation impulse test ing in the High Voltage Laboratory.

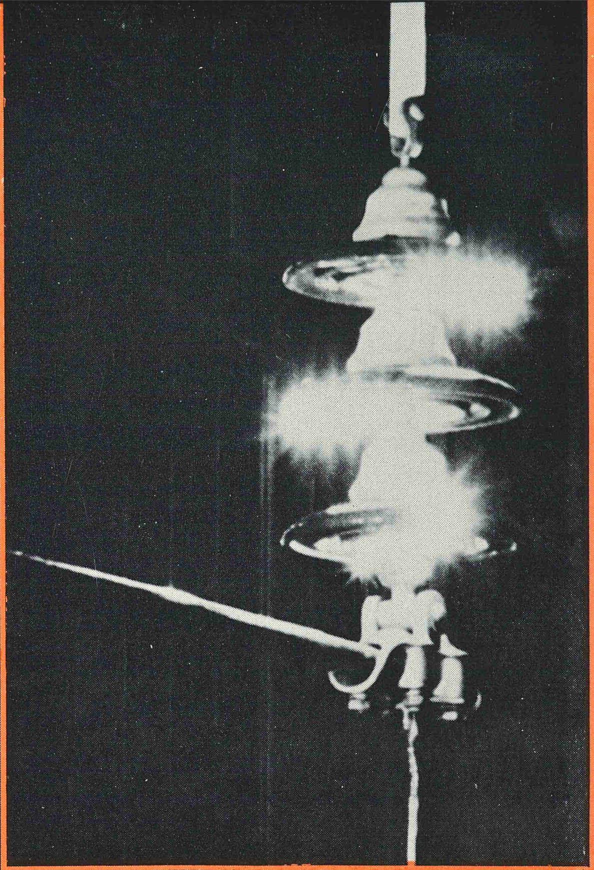
**6⅛-inch section x 11½-inch porcelain**

"Preferred geometry" remains nearly the same. Larger size required to maintain electrical balance with 50,000-pound rating of this EHV suspension insulator.

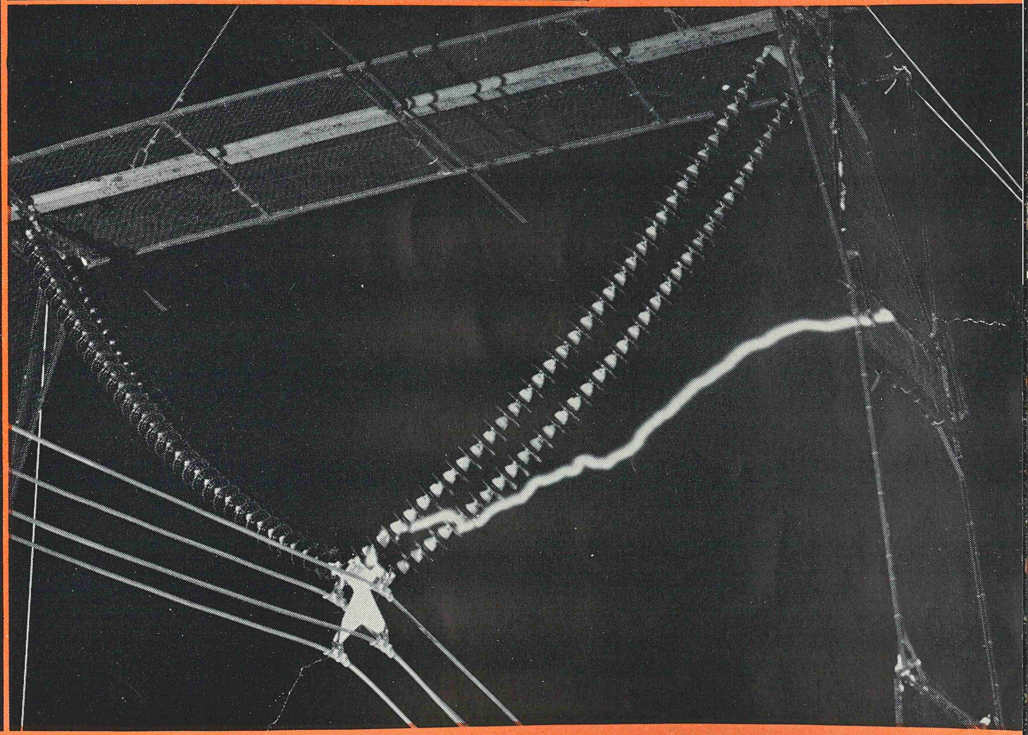






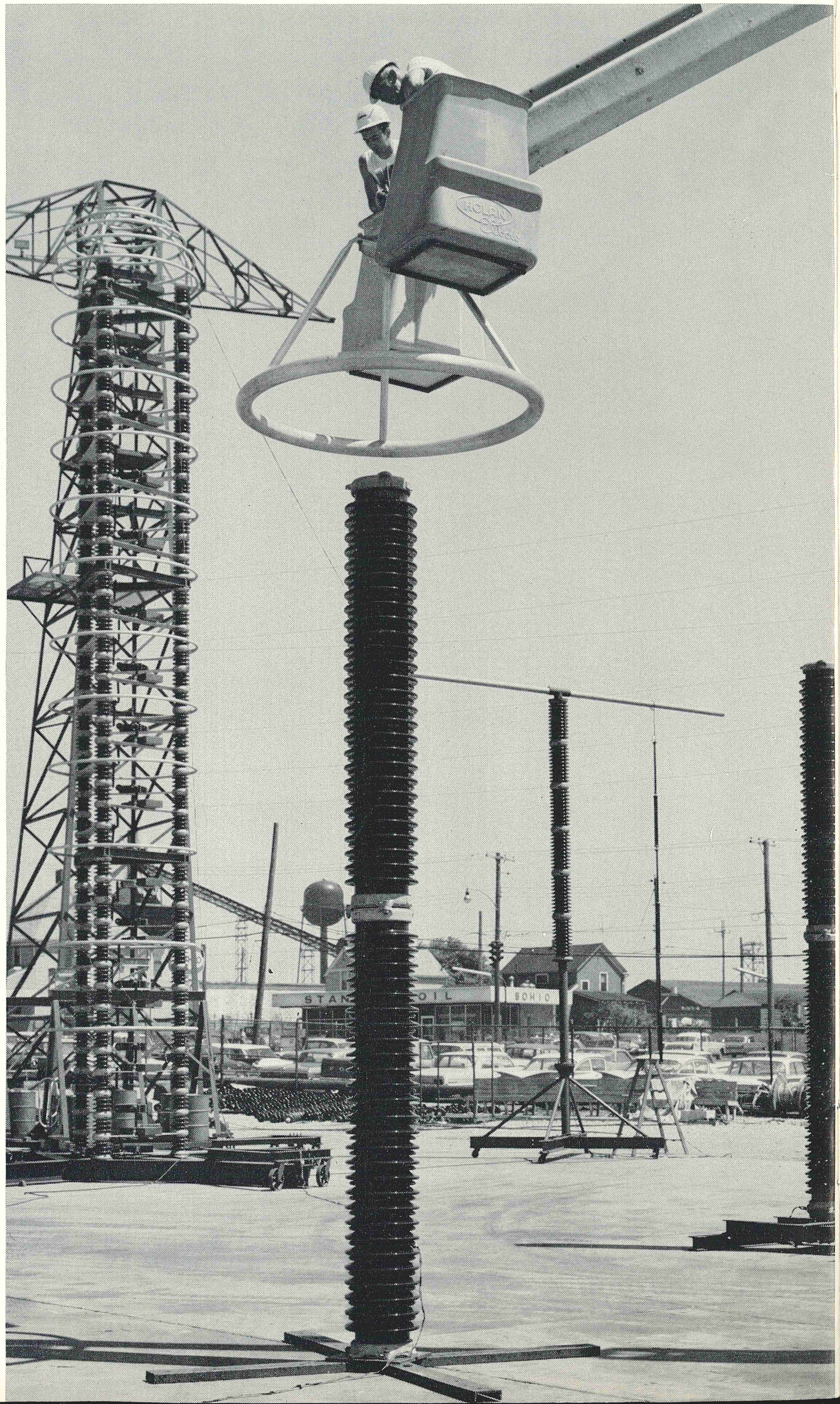
**Steep Wave Impulses** applied to insulators confirmed "preferred geometry" and led to extending leakage distance by adding more petticoats on the bottom side of disc porcelains.



**Lightning Impulse** produced in the High Voltage Laboratory further established "preferred-geometry" design of O-B suspension insulators during evaluation and development testing of original concepts.

**Switching Surge Impulse** testing established new considerations for EHV line insulation. At higher voltages such as the 735-kv flashover shown here, tower clearance and insulator string length go up together for higher withstand.

# Surge testing determines performance characteristics of EHV station equipment



Laboratory crewmen lower the control ring onto an MPR-432 arrester prior to conducting surge tests. Continuous testing in the O-B High Voltage Laboratory probes the protective characteristics and surge durability of Thorex arresters.

Continuous surge testing enables O-B to verify the insulation strength and application ratings for Ohio Brass bushings, potheads, posts, and pincaps, plus the surge durability and protective characteristics of Thorex lightning arresters. O-B's High Voltage Laboratory is constantly probing EHV station equipment designs.

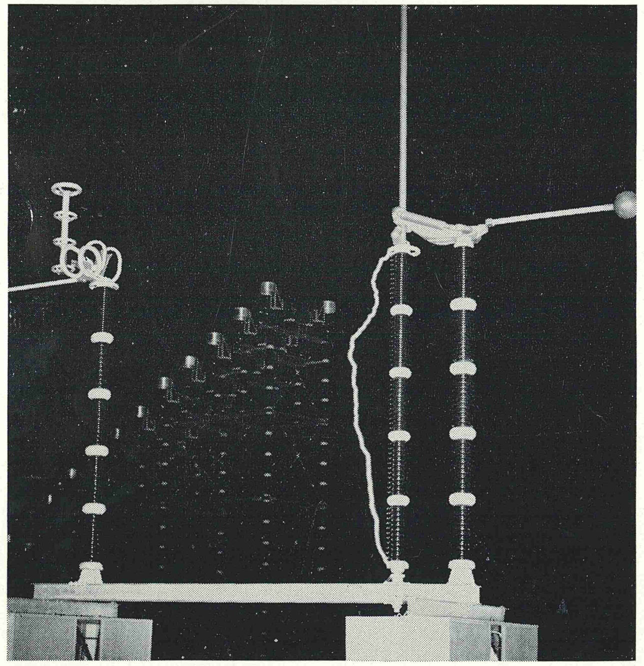
Bushings, potheads, arresters, and other station equipment receive surge tests for one basic reason -- to verify insulation or protective characteristics. With this information, system designers begin their insulation coordination studies. During the preliminary stages of insulation coordination, the system planner chooses the correct arrester sparkover voltage for his system. Arrester sparkover should be safely below the insulation strength of the terminal equipment. Tests conducted in the High Voltage Laboratory simulate the effect of lightning and switching surges to determine the performance characteristics of O-B equipment.

Ohio Brass conducts detailed surge investigations to verify lightning arrester protective characteristics and surge durability. These tests determine arrester sparkover, IR discharge voltage, surge discharge capability, reseal ability, and energy discharge capacity of Thorex lightning arresters.

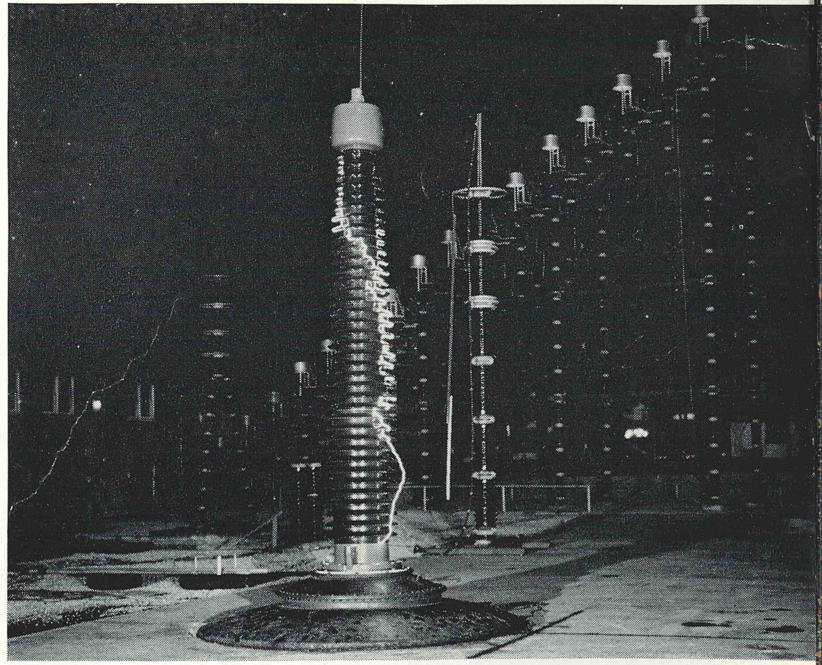
Investigations of the protective characteristics of arresters yield the exact sparkover and IR discharge voltages of the arrester. Research and development projects using information derived from this continuous testing have established control of Thorex arrester sparkover characteristics within a narrow flat band and have significantly reduced IR discharge voltages.

Durability tests include high-current-discharge, duty cycle, and transmission - line - discharge tests. High-current surges probe the arrester's capability to discharge lightning strokes. Duty cycle testing checks the arrester's ability to reseal after discharging a surge. Transmission - line - discharge tests examine the arrester's capability of discharging large blocks of energy.

In addition to surge tests, all O-B station equipment products receive thorough 60 - cycle - withstand and RIV design tests in the O-B High Voltage Laboratory. Performance information may be derived for equipment to be used on systems operating at voltages in excess of 1-million volts.



Surge tests on full-scale switches establish the insulation strength of O-B stacking post insulators and aid insulation coordination studies.

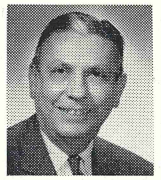


A surge flashover was induced on this O-B transformer bushing by the 4-million volt-generator in the background during a series of insulation-strength investigations.

**OHIO BRASS MANAGEMENT REPORT**

# You pay your rent and get it back with interest

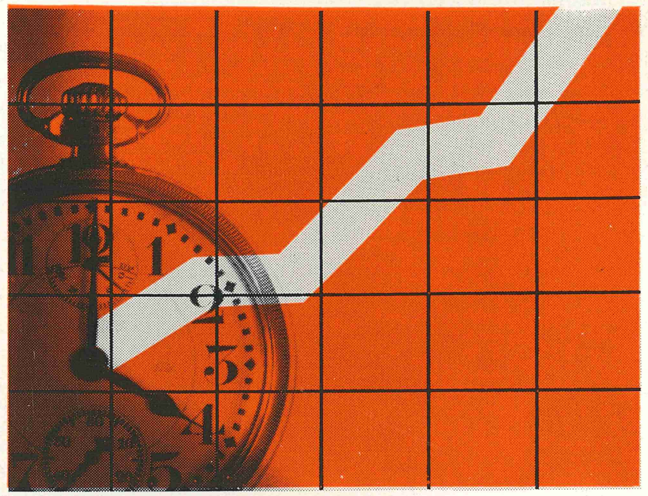
**BY ROGER A. BLACK**
PRESIDENT, OHIO BRASS COMPANY



Perhaps the Christmas season would be a good time to explore the ramifications of a not-so-hypothetical question that any one of you might ask: "So your executive vice president heads the Johnny Appleseed Boy Scout council, how does this improve the quality of your insulators?"

**THE ANSWER IS SIMPLE:** "It doesn't improve them." But I'm sure that electric utilities appreciate, probably more than any other segment of business, that business owes something to the community, the industry and the world in which it lives. The president of a leading drug company once said that each of us owes "rent" in the form of community service for the privilege of doing business in a free country. And the more successful the person, the bigger place he occupies in the world, the more rent he owes.

**THE OTHER SIDE OF THE STORY** is that the businessman can scarcely afford to withdraw from the world, even if he could. The most partisan supporter, for example, of the War on Poverty will concede that the program has been abused. In practice, the Economic Opportunity Act hasn't always given help where it was needed most. But sitting on the sidelines and complaining is hardly the answer. The money that's being spent is yours and mine. It comes from your company and my company. When and where we can, we should use our influence to make sure it's spent properly. And more important, that the people who are supposed to benefit get the benefits.



**OFTEN COMMUNITY OR INDUSTRY SERVICE** contributes more to the participant than he gives. It takes people out of their area of specialization. An accountant learns how engineers think. An engineer learns appreciation of behavioral sciences by working with teachers and personnel men. And they all come back to the company the better for the experience both in terms of what they have learned and in terms of a personal feeling of accomplishment.

**POSSIBLY,** my original answer is wrong. It could well be that community service makes each of us a better person. And ultimately, we'll have better insulators and you'll give better electrical service as the result. In other words, after we pay the rent, we may get it back, with interest.

745-H


OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

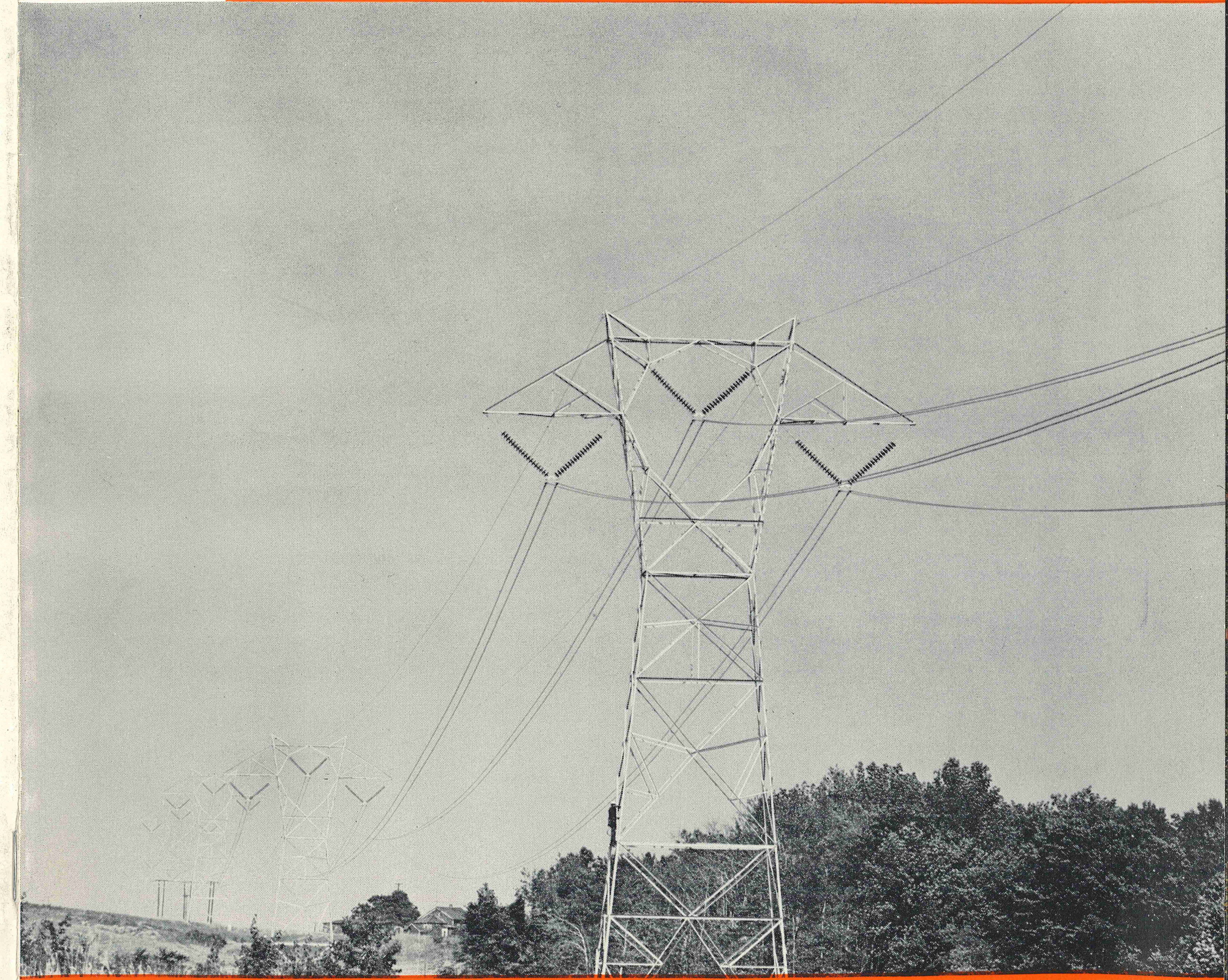
OHIO BRASS

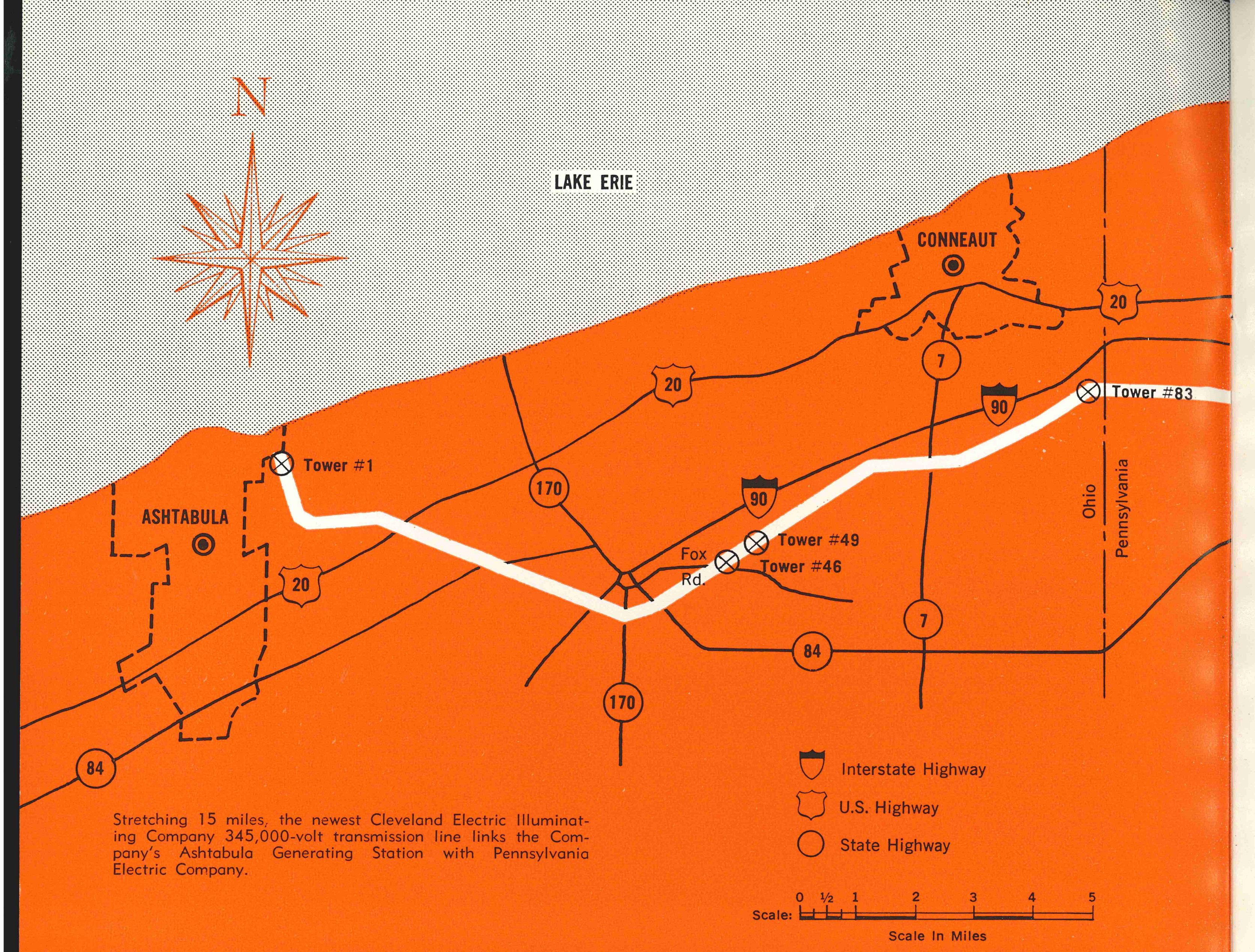
6662-H Printed in U. S. A.



# Hi-Tension News

FEBRUARY 1966




Stretching 15 miles, the newest Cleveland Electric Illuminating Company 345,000-volt transmission line links the Company's Ashtabula Generating Station with Pennsylvania Electric Company.

# Cleveland Electric Illuminating Company builds second 345-kv Intertie

## New construction patterned after existing 345-kv line — V-strings in all phases, narrow towers, and O-B materials

Sixty miles east of Cleveland, Ohio, the newest Cleveland Electric Illuminating Company 345,000-volt transmission line crosses Interstate Route 90 and swings east to the Ohio-Pennsylvania line to tie with Pennsylvania Electric Company. Following the right-of-way north leads you to Tower Number 1 at CEI's Ashtabula Generating Station. In all, the total length of CEI's section of this new intertie measures 15 miles -- short by today's EHV standards, but an important addition to CEI's total system capability.

Cleveland Electric Illuminating Company is a member of the Interconnected Systems Group, composed of 173 operating systems in 40 states and two Canadian provinces. Each utility derives the benefits of power interchange during peak loading and emergencies.

CEI's newest EHV line adds an additional system transmission capacity of 352 MVA, plus a tie with another company. It crosses rolling countryside with construction patterned after CEI's 60-mile Canton-Cleveland 345-kv line built in 1963. Narrow towers and phase spacing add to the appearance and performance characteristics, and result in an attractive silhouette on a line with very low inductance for maximum transmission capacity. Total right-of-way procured by CEI measures 200 feet in width and will be shared by a one-circuit 345-kv line and a double-circuit line of 138 kv.

Construction of CEI's 15-mile section began in July, 1964, with the pouring of the tower foundations at positions determined by a combined aerial survey and computer program. All 83 towers placed on the new line route are self-supporting structures with compacted concrete footings. Tangent tower footings vary between two feet and four feet in diameter and eight- to eighteen-feet deep, depending on loading and soil conditions encountered. Each tower is grounded with an eight-foot rod, which is connected to the tower with a short length of cable bolted to the base. Throughout the line, ground resistance totals less than ten ohms per tower, with an average of five ohms.

Average height of the single-circuit towers at the ground-wire support is 93.5 feet. The dual-conductor bundles remain 70 feet above the ground at each tower, protected by an 18.5-degree shielding angle. Phase spacing measures 20.5 feet center-to-center, with a total crossarm length of 60 feet. Striking distance from the tower steel to the conductor bundle measures a minimum of eight feet. Spans along the new 345-kv line have a maximum length of 1250 feet, with an average span of 970 feet -- or 5.75 towers per mile. In mid-span, conductors maintain a minimum ground clearance of 35 feet.

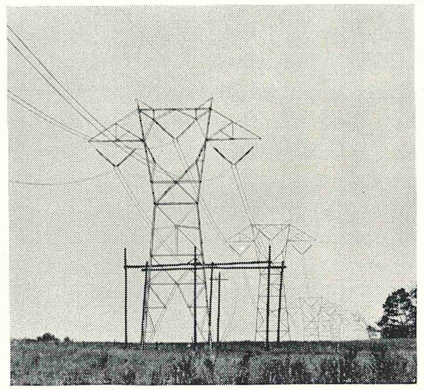
V-string insulation in all phases on tangent and light-angle construction permits the efficient compact design of the new CEI line. Eighteen 15,000-pound ball-socket insulators support each leg of the V-string at tangent positions. Light angles use nineteen 25,000-pound units on the angle-restraining leg of the "V," and the standard eighteen 15,000-pound insulators on the stabilizing side. Double, tangent strings of 25,000-pound ball-socket insulators support the dead-end and heavy-angle positions. Smogtype insulators were installed on the first mile of line because of high contamination in the area. All insulators used on the complete 345-kv line were furnished by Ohio Brass Company.

All links, wye-clevis eyes, shackles, wye-clevis sockets, and ball eyes receive a hot-dip galvanized coating for maximum corrosion resistance before leaving the O-B factory. The "stabilized" yoke used on the new CEI line is manufactured from structural steel. Controlled contours and surfaces assure optimum corona performance without control rings. Elimination of control rings on the new intertie resulted from the operating experience gained on the Canton-Cleveland line which was constructed with the same O-B materials.

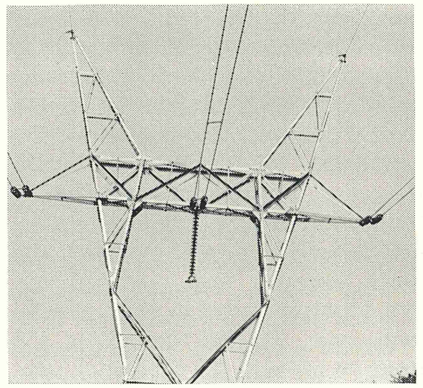
Installation of the insulator-hardware assembly on the new CEI line begins with attachment of the stringing blocks to the yoke plate. Then, a sling is attached between the fifth and sixth insulator units and the first and second units. The lifting line attaches to the sling, leaving the extension link free to be adjusted to the tower attachment point. The sling attachment protects the insulator ball joint from possible pin bending which could develop a stress point for future vibration damage. Linemen on the tower guide the extension links into place as the assembly is raised with the use of a construction tractor. Removal of the link's clevis bolt and cotter allows alignment of the tower attachment point and clevis connection. Then, the bolt and cotter are reinserted into the link for permanent installation.

With the insulator-hardware assemblies installed in all three phases on approximately six towers, the stringing operation begins. A wire leader strung through all six towers

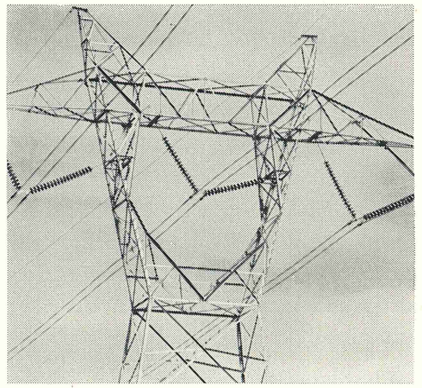
*(Continued on next page)*



Narrow towers and right-of-way produce an attractive silhouette and several performance advantages on the Cleveland Electric Illuminating Company's new 345-kv transmission line.



Tower 83 stands ready to deadend the tie with PENELEC to establish another interconnection for CEI. The company presently interchanges power with 173 utilities in 40 states and two Canadian provinces.



Light angles use a special insulator-hardware design, composed of an O-B angle yoke plate, nineteen 25,000-pound insulators on the angle-restraining leg of the "V," and eighteen 15-000-pound O-B suspension units on the stabilizing side.

OB Hi-Tension News
FEB. 1966, VOL. 35, NO. 2
OHIO BRASS CO., MANSFIELD, OHIO

**ON THE COVER** - Application of V-string and O-B close-coupled insulator-hardware design principles resulted in narrow towers and right-of-way on the newest 345,000-volt transmission line of Cleveland Electric Illuminating Company.

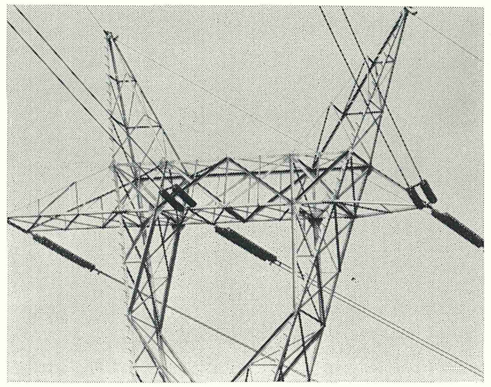
*(Continued from previous page)*

attaches to a divider yoke connected to the two 1.175-inch-diameter 48/7 ACSR conductors. One complete phase is pulled through, tensioned, then tied off to await clipping in. As the conductors pay out, they pass through a tensioning machine which automatically maintains a stringing tension of 5500 pounds (at 60-degrees (Fahrenheit). With the dual-conductor bundles installed in all three phases, the ground wires are strung and tensioned.

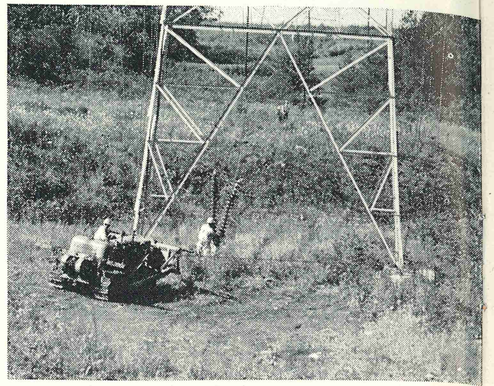
To complete the installation of a support point, CEI crewmen perform the clipping-in operation. After climbing the tower, the linemen suspend a lightweight tower ladder from the crossarm, attach all hand lines, and climb down to begin removal of the stringing blocks. A special six-foot-long lifting yoke is attached to the conductors, and connected to a chain hoist hooked to the tower. As one lineman hoists the conductors off the stringing block, the other attaches a hand line to lower the block to the ground. All attachment bolts are removed, the block lowered, and a wye-clevis-eye fitting installed in each attachment hole. To this wye fitting, the linemen connect the conductor support to complete installation of a single phase. With all three phases complete, the crew moves to the ground-wire support at the tower top, where a standard O-B suspension clamp for 7 Number 8 stranded wire is installed for support. Total time for clipping-in a tower -- slightly over one hour.

Initially, the new line will be energized at 230 kv, with the voltage raised permanently to 345 kv as the system load increases. Even as the new CEI-PENELEC 345-kv line nears completion, Cleveland Electric Illuminating Company prepares for construction of additional 345,000-volt circuits.

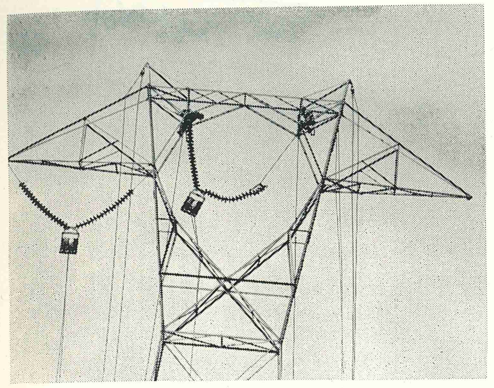
Photographs included on these pages illustrate general line views and construction at Towers 46 and 49 near the intersection of Interstate Route 90 and State Route 84 early in September, 1965.



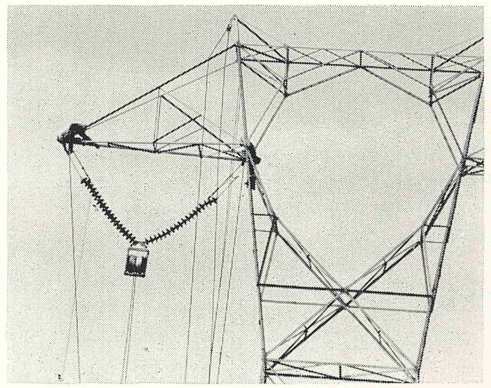
Deadend structures support the line terminations and angle positions greater than 20 degrees, using twin strings of 20 O-B 25,000-pound ball-socket insulators. Here an angle of 30 degrees at Tower 60 waits for installation of the jumper loop before completion and energization of the line.



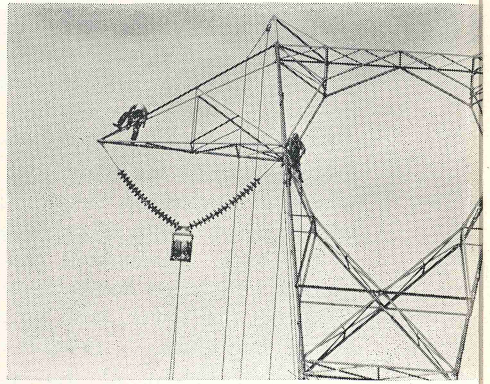
Ground crewmen loop a rope under the first and fifth insulator units to form a sling, then attach a lifting line connected to a construction tractor which pulls the insulator-hardware assembly up to the linemen. The stringing block with a guide rope attached is connected to the yoke before lifting.



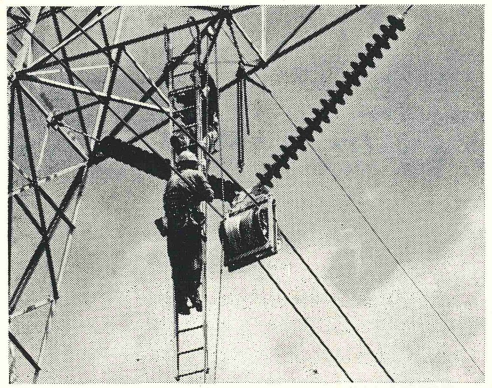
As the insulator-hardware assembly rises into position, one lineman guides the extension link to the tower connection as the second is in position to attach the other side. One leg of the V-string is raised for installation at a time by maneuvering the construction factor left and right.



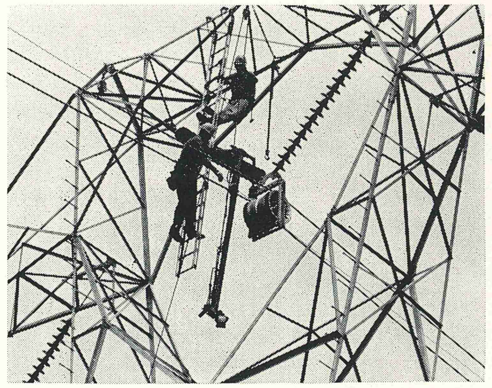
As the links approach the tower connection, the clevis bolts are removed, then slipped back in and secured with a cotter for permanent installation.



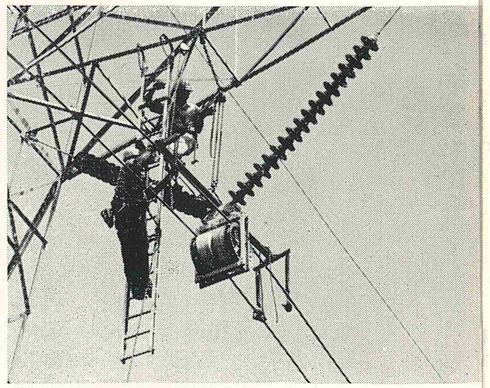
With the insulator-hardware installed in the left phase, the linemen carry their hand lines across the crossarm to prepare for receiving the next assembly.



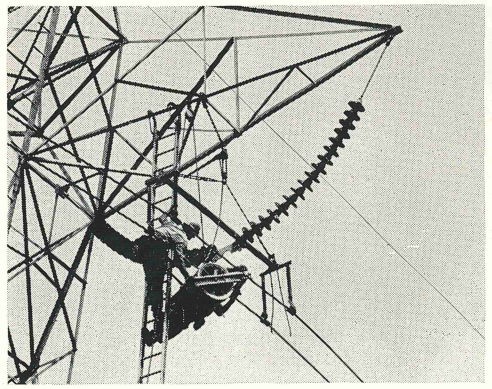
Belted to the tower ladder, one lineman prepares to loosen the stringing block attachment bolts as the second installs the lifting hoist.



The linemen raise and guide the lifting yoke into position prior to removing the conductor load from the stringing blocks. Eighteen, 15,000-pounds insulators support each leg of the V-string.



With the chain hoist attached to the lifting yoke, one lineman begins to crank the conductors off the blocks as the other aligns the lifting yoke to receive the conductors.



With the stringing block free, the linemen lower it to a truck for storage, then proceed with the installation of the wye-clevis-eye attachment fitting and conductor supports.



# National Electrical Week Retrospect: 88-Year Introduction to Electricity's "MAGIC"

It's easy to believe this year's theme for National Electrical Week, February 6 through 12: "Electricity Makes A World Of Difference." In the 88 years since the invention of the incandescent light gave birth to the industry, the "magic" of electric power has proved itself time after time. More new products and uses for electric power are introduced every year which produce new "magic" in convenience and savings in time and energy.

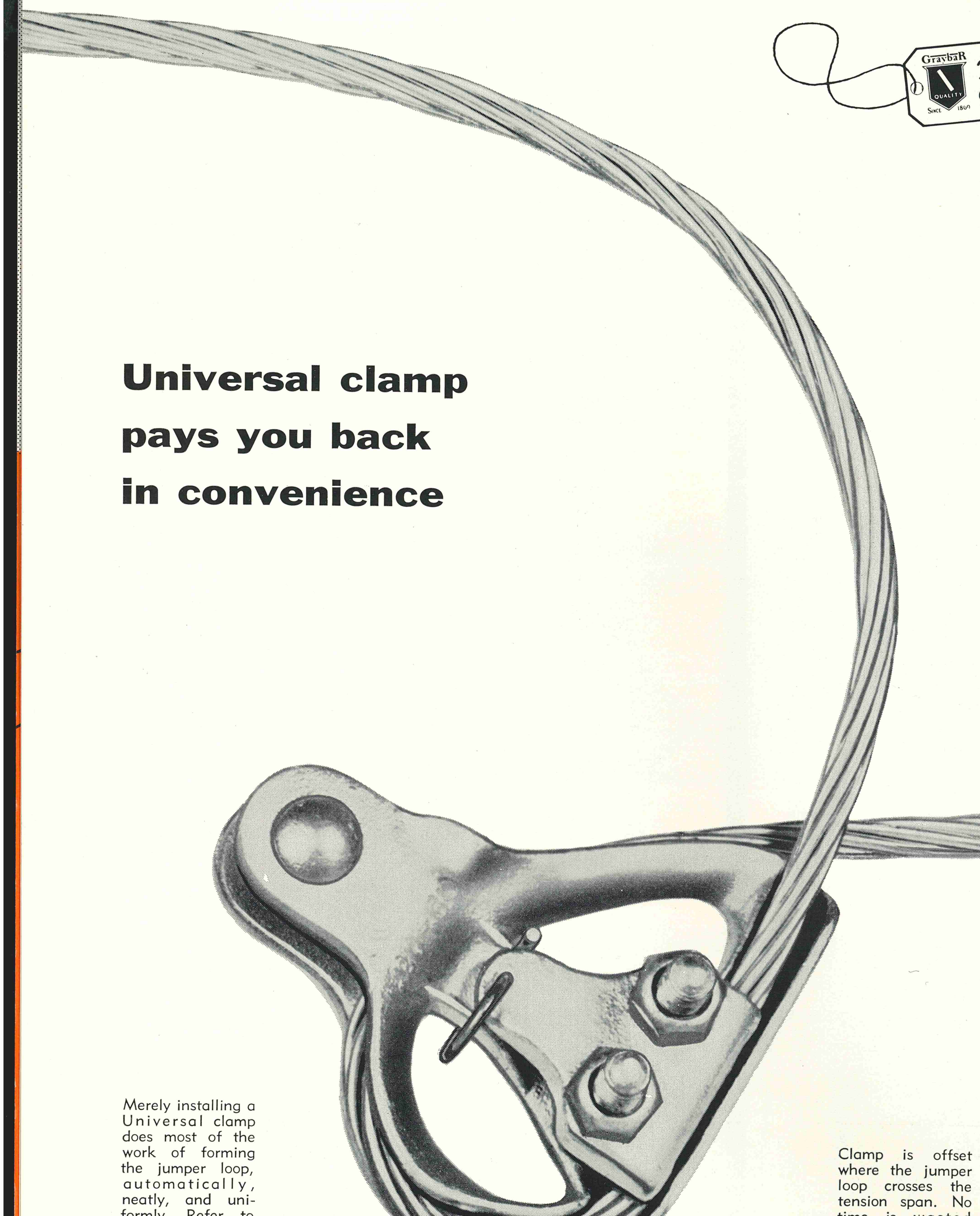
Since its beginning, the electrical industry has maintained one of the steadiest growth records in history. Power demands double and redouble an average of once every ten years. This growth "magic" offers an excellent opportunity for manufacturers serving the electrical industry, plus presenting a challenge to youth seeking a career with a future.

While the demand for electric power continues to grow and utilities invest large sums in new generation and transmission equipment, the per-kilowatt-hour cost of electric power has constantly reduced -- another kind of "magic" consistent with the industry's growth. Here is where Ohio Brass contributes to the future of the electrical industry. To develop new products and designs for the most efficient support, insulation, and protection of electric power systems, O-B maintains a constant research and development program in the O-B Mechanical, Ceramic, and High Voltage Laboratories. The facilities and capabilities of these laboratories are continuously being expanded better to serve the future needs of the electrical industry.

During the 1966 observance of National Electrical Week, we at Ohio Brass would remind our employees, communities, and associates of the historical truth of this year's theme, plus the promise for the future. And, to further substantiate our belief in the industry, O-B pledges to continue the search for new products and designs to help the electrical industry put more "magic" in the future.

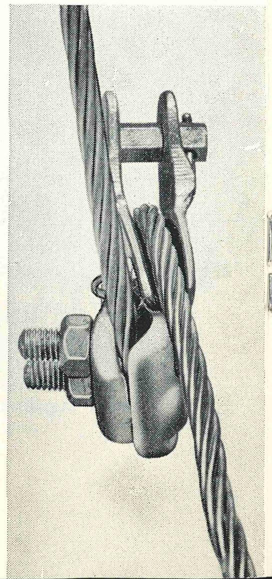
NATIONAL ELECTRICAL WEEK

FEBRUARY 6-12, 1966



# Universal clamp pays you back in convenience

Merely installing a Universal clamp does most of the work of forming the jumper loop, automatically, neatly, and uniformly. Refer to O-B Catalog Number 88500. Clamp capacity, 0.2 to 0.5 inch.



Clamp is offset where the jumper loop crosses the tension span. No time is wasted spreading the conductor at this point to avoid chafing of strands.

## Develops high holding strength without damaging conductor

As long as a distribution clamp lies on a shelf in the storeroom, *you don't know what it costs.* You have to pay a man to install it before you get a figure.

When a lineman up a pole is handling an O-B Universal clamp, it's working for him . . . not against him. The clamp may save enough time to pay a considerable part of its first cost. We would like to back this statement with a few facts. Here they are:

If a man with heavy gloves has to thread-on ½-inch nuts, it is only a question of time until he drops one. Have you ever conducted a "nut hunt" in deep grass at the base of a pole or, worse yet, in a pile of snow? You don't remove the nuts or lockwashers from a Universal clamp. You simply back them off until the jaw opens wide enough to accept the conductor. Then tighten them down again.

As the nuts are backed away, the jaw opens and stays open by spring pressure. It's like giving the lineman an extra hand. He doesn't hold the jaw open to form the conductor. It speeds up the job considerably when he is not switching his hands back and forth.

As the conductor goes into the clamp, it automatically forms a jumper loop, neatly. There is no additional bending and shaping.

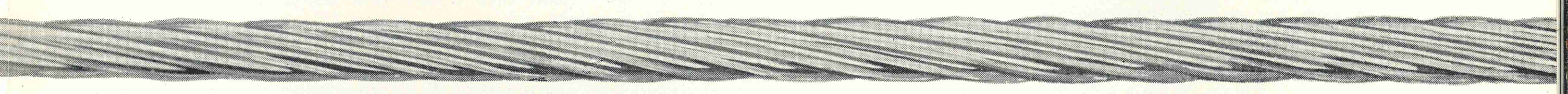
At the crossover point in the jumper loop, the conductor is positively held apart by the clamp. The lineman has no problem of spreading the loop to avoid chafing of strands. This has been built into his job.

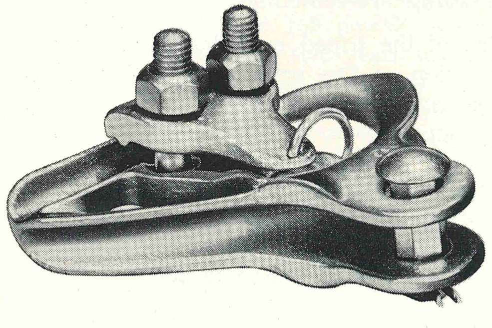
Tightening the jaw is done by drawing down two nuts, generously spaced so a socket wrench will fit, or not to cause interference if using an end wrench. These nuts are in handy position . . . the man need not stand on his head to get at them. Edges of the nuts and ends of the studs are smoothly rounded to avoid skinned knuckles.

There are some advantages that don't concern the lineman. Circular shape of the Universal seat provides more than 180 degrees of snub that materially adds to the holding power of the clamping jaw.

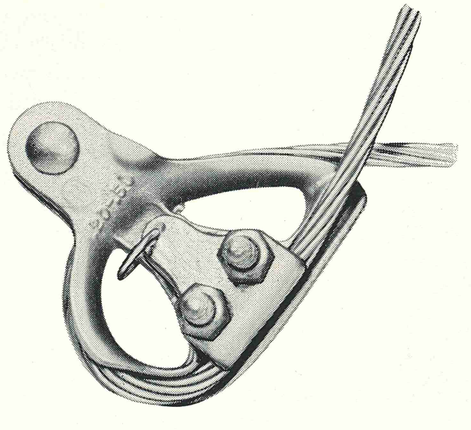
Design of the jaw develops a powerful grip without nicking or damaging the conductor's surface. If it is ever necessary to alter construction, a previously clamped point can be safely moved into the open span, with the old grip scarcely noticeable, and with its original strength in no way deteriorated.

The great majority of orders for Universal clamps are repeat orders . . . the clamp seems to be habit-forming. If you haven't developed the habit, at least expose yourself to it. Unlike so many habits, this is a good one.

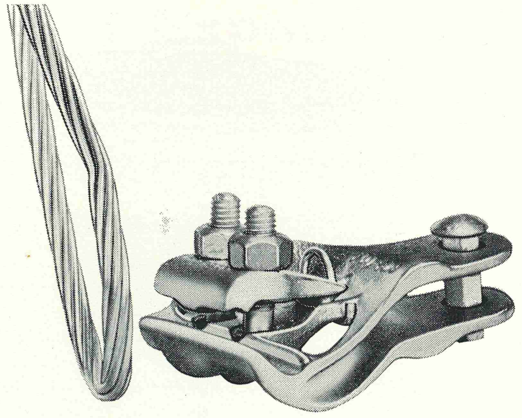




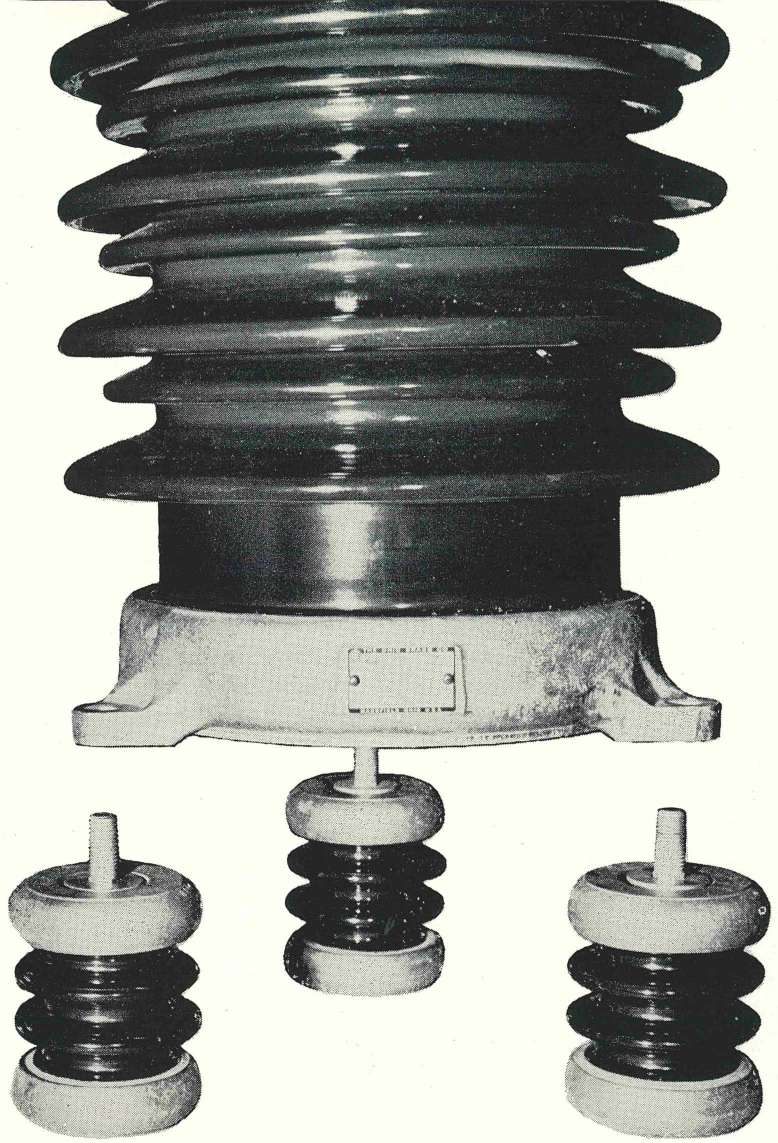
Jaws are held positively open by spring pressure. In wide open position there is ample thread left on the stud. Nuts and lockwashers are never removed . . . never dropped.



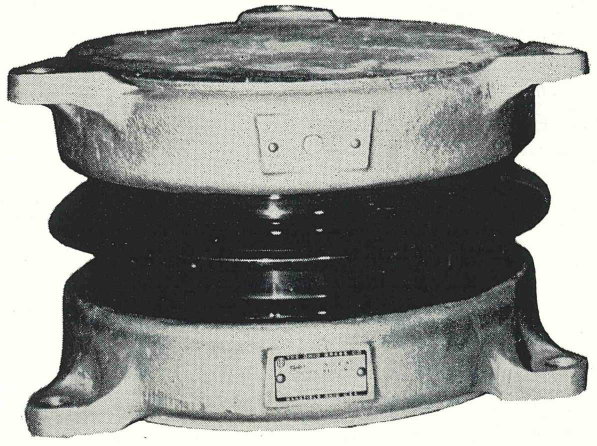
Over 180 degrees of snubbing power is added to the strong grip of the jaw. This combination gives the Universal clamp exceptionally high holding strength.



This piece of conductor was installed under maximum clamp pressure, and then removed. Note small degree of deformation and complete lack of surface damage.



Tripod post subbase (Catalog 046999) insulates arrester base from mounting surface by supporting each lug on a suitable porcelain spacer.



Single-piece porcelain subbase (Catalog 046799) using arrester end cap castings separates arrester base from normally grounded support structure.

# Insulating subbases facilitate counter installation on O-B MPR station arresters

Provision for the connection of operation counters is a common installation requirement for station-class lightning arresters. In addition to providing valuable information in respect to the proper functioning of the arrester, operation counters are the source of essential data in relation to performance studies of the coordination of system insulation and protection. Even on applications not originally specifying the installation of operation counters, it is considered good practice to incorporate the necessary mounting modifications in anticipation of future needs.

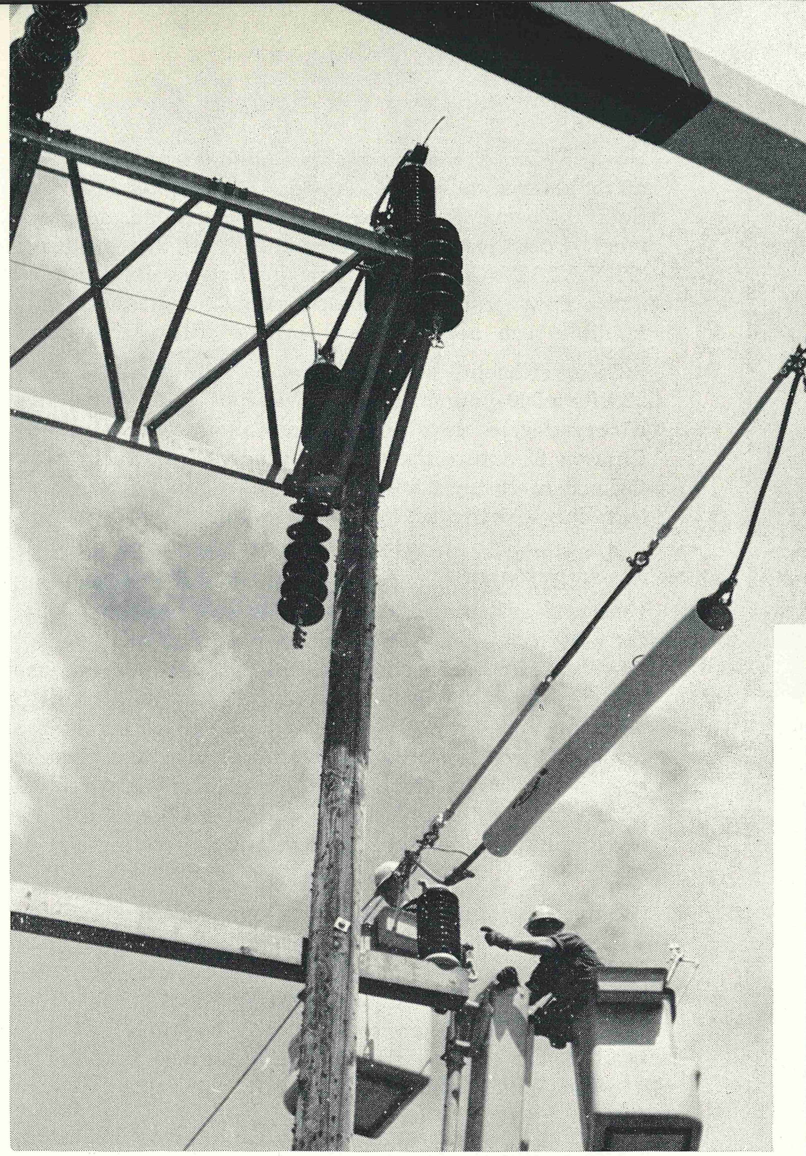
Principal requirement for installing instrumentation capable of recording arrester operations is that the device can be electrically connected in series with the ground cable of the arrester. If the recording instrumentation is not installed at the time the arrester is connected to the line, a jumper cable must be used to provide a direct ground for the arrester.

Isolation of the normally grounded arrester base is usually accomplished by mounting the arrester on a suitable porcelain subbase. Two styles of insulating subbases are available from Ohio Brass. As shown in the lower portion of the illustration, the conventional subbase assembly consists of a large diameter porcelain section to which two malleable iron end castings similar to the arrester end castings are cemented.

The alternate design of the tripod posts has greatly simplified the construction of the arrester insulating subbase. Individual porcelain posts of relatively small diameter are used to support each of the arrester base mounting lugs. Each of these posts is fitted with ¾ inch - 10 studs of sufficient length to facilitate installation. Three posts are used for each arrester except on the highest-rated EHV arresters where the number of supports required is increased to six.

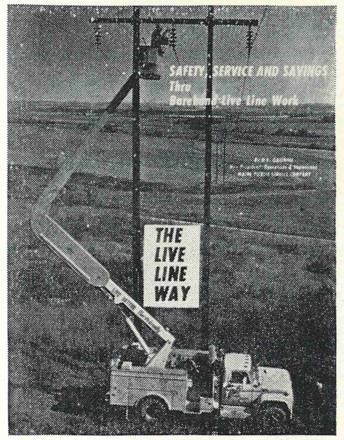
The cantilever strength of the tripod post-type insulating subbase is 150,000 inch-pounds. Net weight of the three posts required for normal installations is 33 pounds, more than 50 pounds lighter than the weight of the single-piece porcelain MPR subbase.





Two Holan elbows plus crews trained for Live Line Barehand Method maintenance worked over 7,000 unit hours over the past 30 months, preventing over 150 power outages for Maine Public Service Company.

Reprints of the discussion "Safety, Service, and Savings Through Barehand Live Line Work" are available to interested maintenance personnel through Maine Public Service Company.




# Success of applied Live Line discussed at National Safety Congress and Exposition

Maine Public Service Company prevented over 150 power outages on its system in two years through applications of the Live Line Barehand Method. Daryl E. Gaiennie, vice president, engineering and operations, for the company, reported the success of applied Live Line when he discussed "Safety, Service, and Savings Through Barehand Live Line Work" during the 1965 National Safety Congress and Exposition at Chicago, Illinois.

Over the past 30 months, Maine Public Service line crews used two Holan aerial elbows -- one 50-foot unit and one 57-foot unit -- a total of more than 7,000 unit hours. All work was performed in accordance with established principles and practices of the Live Line Barehand Method. Voltages worked varied from 2.4 kv to 69 kv, with the major portion of the lines located in rural areas along secondary roads. Access to many of the work areas was limited, but posed no problem.

During his discussion, Gaiennie discussed methods used during the training of crews who were accustomed to working with "hot-stick" procedures, familiarizing crews with live line tools, and the maintenance of crew morale. Several work reports were presented during the discussion, illustrated with slides of actual maintenance operations.

A complete reprint of Gaiennie's discussion with photographs has been prepared and is available to interested maintenance personnel. For copies of "Safety, Service, and Savings Through Barehand Live Line Work" by Daryl E. Gaiennie, write to: Maine Public Service Company, Presque Isle, Maine.

# Three Holan Engineering advances assure safe and reliable operation of new Charger 82

Holan's new Charger 82 Squirt Boom is a mobile and maneuverable unit capable of placing 300-pound payloads in aerial positions for installation and maintenance of streetlights, distribution power lines, and mid-span service taps. Revolutionary "HOLSTAT" Control System simplifies operation, adds to safety, and increases reliability of the extendible-boom unit.

Now, Holan Division of The Ohio Brass Company manufactures and markets an all-new Charger 82 Squirt Boom. Four years of concentrated development work resulted in adaptation of the exclusive "HOLSTAT" Controls, a new bucket-leveling system, and a new control-line compensation system to an extendible arm aerial device for the utility industries.

Safe, efficient, and trouble-free, the new Charger 82 lifts a 300-pound payload to 40-foot working heights. Ninety-degree elevation and continuous rotation of the Charger 82 assure the versatility needed for such aerial tasks as re-fusing transformers, making mid-spand taps, installing electric service, or servicing streetlights.

A unique feature of the new Holan squirt boom is the "HOLSTAT" Control System. It differs from conventional systems in that controls are separated from the operating system. A ¾-inch multiple signal control line located within a separate externally mounted housing eliminates the conventional bulky bundle of high pressure lines formerly contained within the extendible boom. External positioning of the control line permits easy maintenance and service. Control signals applied at the bucket through the small "static" fluid column are amplified to actuate the hydraulic operating circuit in the lower arm and pedestal.

Since no high pressure lines are contained in the upper arm, fluid leakage -- which can cause loss of dielectric strength and create a fire hazard -- is virtually eliminated. Low temperatures will not affect operation even when conventional hydraulic fluid is used in the control system. And, because the control and hydraulic systems are separate, the control system can be filled with any type of liquid.

Other Holan engineering developments to improve operation and increase the safety of the new unit include an unusual constant radius device that automatically translates changes in angular position to changes in hydraulic cylinder volume; keeping the bucket level throughout the working range. Equally important, Holan's endless-cable mechanism compensates for changing lengths of control line. Automatic compensation and loop storage as the arm moves in and out prevent stress and abrasion of the multiple signal control line.

For more information on the Charger 82 and additional technical data about "HOLSTAT" Controls, write: Holan, Division of The Ohio Brass Company, Cleveland, Ohio 44135.

# Interchangeable Multirester accessories facilitate exact arrester equivalents for distribution class applications

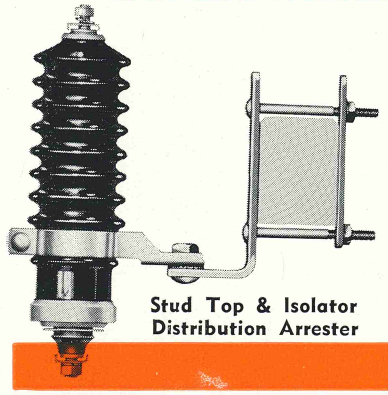
THOREX® MULTIRESTER

The broad adaptability of O-B's Multiresters is particularly advantageous in simplifying arrester specifications for the multitude of variations found in distribution-class service. Accessory items required for arrester adaptation are easily selected and are factory-assembled for convenient installation.

Suitable arrester assemblies can be specified in three quick steps. First option is that of various line terminals, which includes the addition of the external gap feature when required. Second consideration concerns arrester mountings using the conventional clamping band and suitable brackets. Third step provides three distinct choices: one, a ground-wire terminal consisting of stud, nut, and lockwasher; two, a ground-lead isolator, which automatically disconnects the arrester ground in case of fault current; and three, an extension stud to provide simultaneously base mounting and a ground connection.

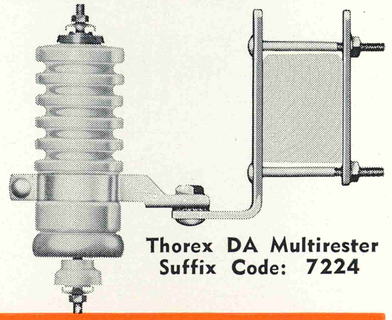
The illustrated chart of Multirester accessories in O-B's Catalog 43 arranges the ordering procedure in logical sequence. Multirester catalog numbers include a suffix code which incorporates number identification of the options selected.

## CATALOG NUMBER SUFFIX CODE INDICATES OPTIONAL ACCESSORIES

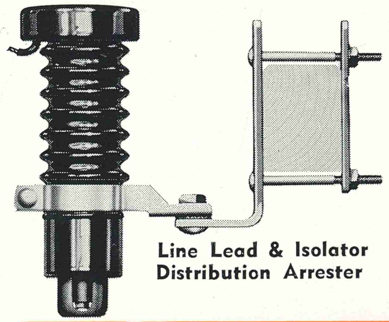


Stud Top & Isolator Distribution Arrester

First example illustrates Multirester equivalent of a stud-type arrester, furnished with conventional line terminal, NEMA crossarm mounting bracket and ground-lead isolator. Multirester suffix code 7224 provides identical facilities: the first "2" secures the corresponding line terminal stud, nut, and lockwasher; the second "2" the arrester clamping band and NEMA crossarm bracket; and the final "4" the ground-lead isolator assembly.

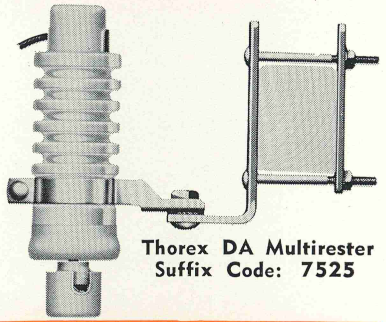


Thorex DA Multirester Suffix Code: 7224

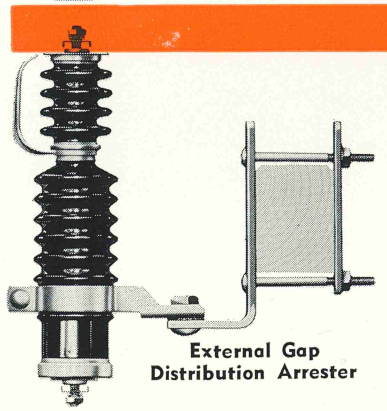


Line Lead & Isolator Distribution Arrester

Second example is the Multirester equivalent of a line-lead-type arrester, furnished with protective top, line lead, NEMA crossarm bracket, and enclosed ground-lead isolator. Catalog suffix code 7525 provides equal fittings: the first "5" secures the top terminal assembly with lead wire and protective cap, the "2" the clamping band and NEMA bracket, and the second "5" the ground-lead isolator with protective sleeve.

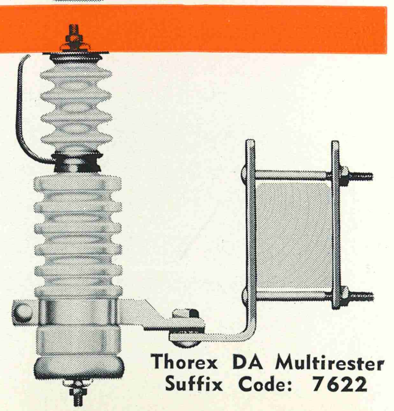


Thorex DA Multirester Suffix Code: 7525



External Gap Distribution Arrester

Third example is the external gap-type arrester, furnished with an air-gap assembly, NEMA crossarm bracket, and stud-type ground terminal. The Multirester equivalent is obtained by catalog suffix code 7622, in which the "6" indicates the gap assembly, the first "2" the clamping band and NEMA bracket, and the second "2" the stud, nut, and lockwasher used for the ground terminal.

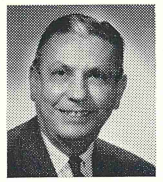


Thorex DA Multirester Suffix Code: 7622

OHIO BRASS MANAGEMENT REPORT

# Improvements in communications, price statesmanship might prevent industry problems

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

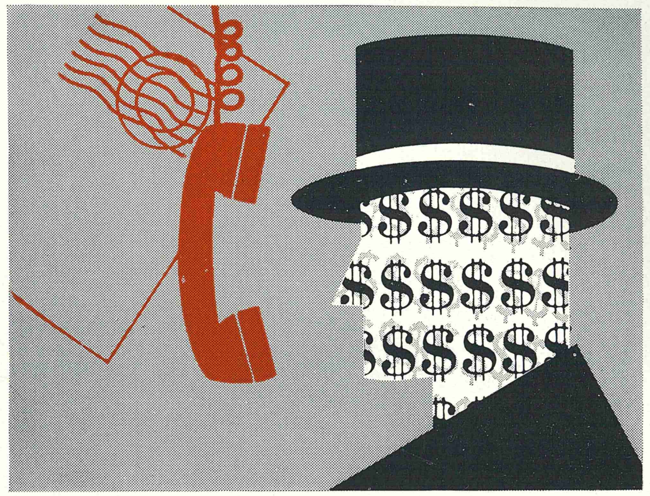


1965 earnings for electrical manufacturers show the best year for the industry since 1957. Despite the improvement I expect to hear the comment: "You would have made more money if you had been able to deliver what we wanted to buy from you."

**YOU HAVE THE RIGHT** to ask why we weren't able to deliver in greater volume and I would make two points in the short space available for discussion. But first I will emphasize the obvious . . . we deplore and regret the delays that occurred in 1965 and are doing everything possible to correct them. Now, what can we—customer and manufacturer—do to prevent recurrence of the problems?

**FIRST, WE WOULD ASK** for better communications. We didn't really know how big the demands for 1965 would be until they hit us. For example, the best available information in September, 1964, showed that your transmission construction expenditures wouldn't exceed $1.3 billion until 1970. But only four months later, in January, 1965, your revised estimates showed that you planned to spend at the 1970 rate in 1965. So the demand hit us five years earlier than expected.

**WE KNOW PLANS CHANGE** almost as soon as they're made in a dynamic business like yours. But we need the best available information to plan intelligently. It might even be practical to feed information from every utility into a central collection agency—EEI, NEMA, the Public Utility Buyers' Group, or an industry publication—which could compile a forecast of utility industry needs for the next five years, with a review every year to update the estimates.



**THE SECOND POINT** . . . during the lean years, between 1957 and 1965, profits were too low for management to justify adding to plant capacity, although Ohio Brass, among others, did it anyway. This would indicate that prices were driven below the minimum needed to sustain a healthy electrical industry. You aren't expected to buy above the market price just to keep a supplier healthy. But once a reasonable price level is established, you can help keep it reasonable.

**WE WOULD NOT DISCOUNT** the problems of today. They are serious. But they represent the pains of dynamic, healthy growth. I much prefer them to the pains that come when we move the other direction, and I hope you agree.

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OHIO BRASS

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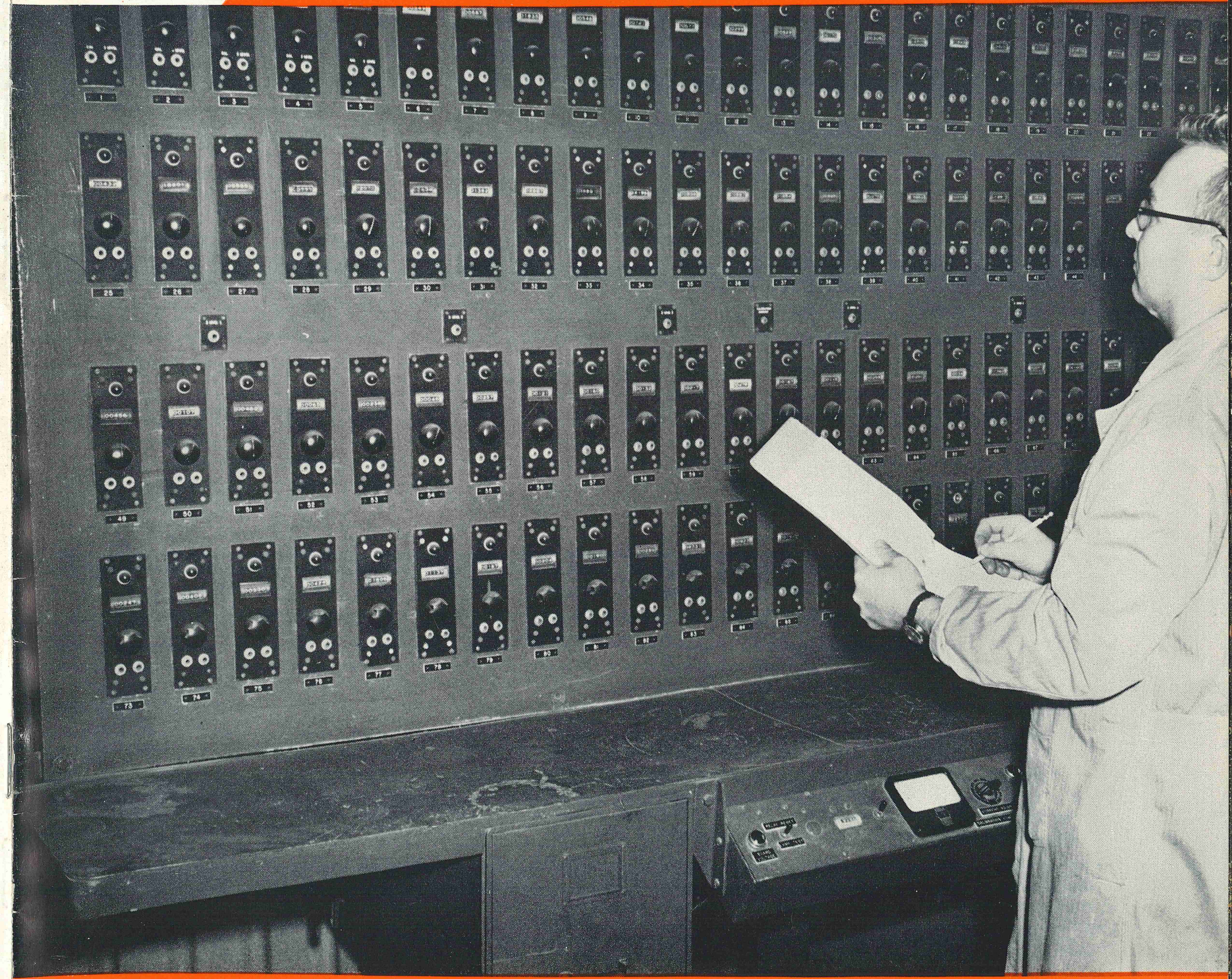
# Hi-Tension News

MAY 1966



## Nerve center of 20-year contamination study

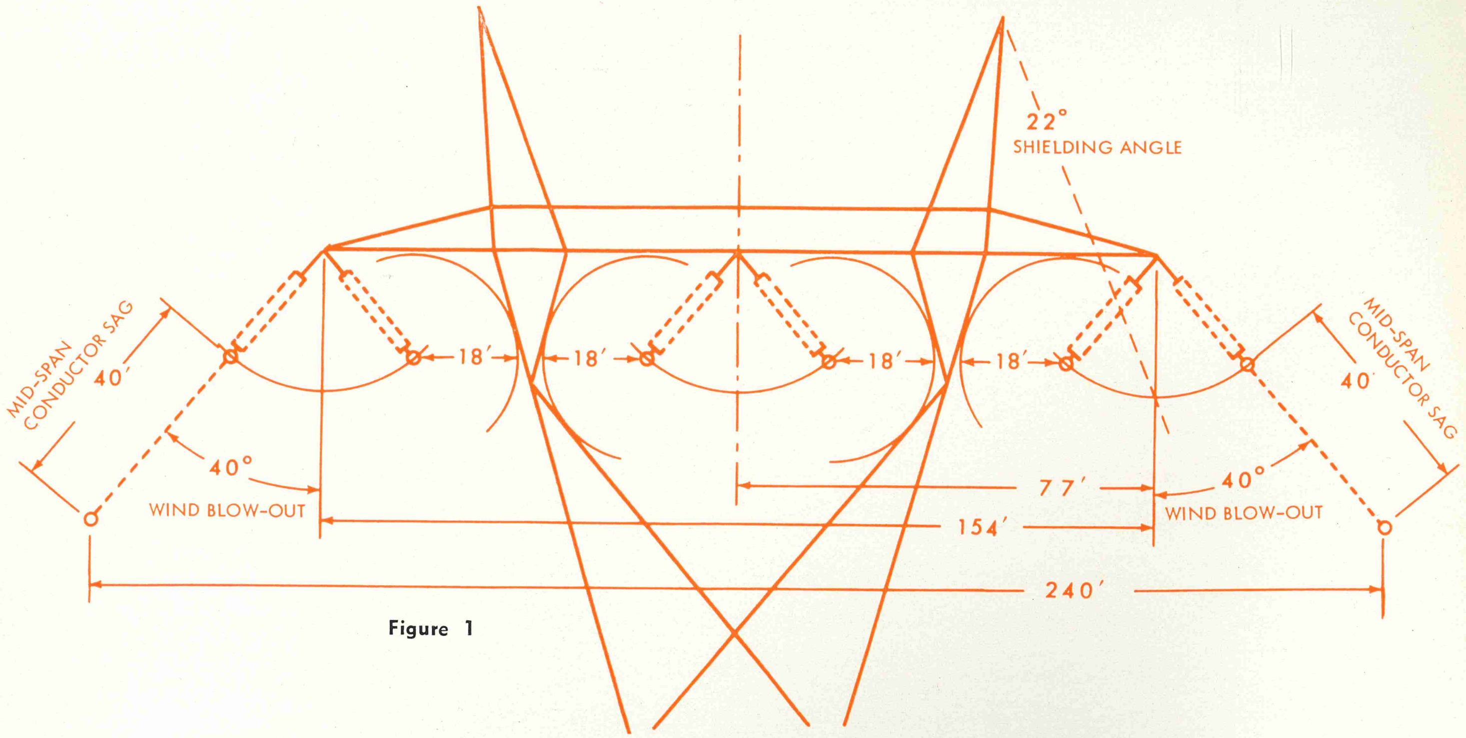
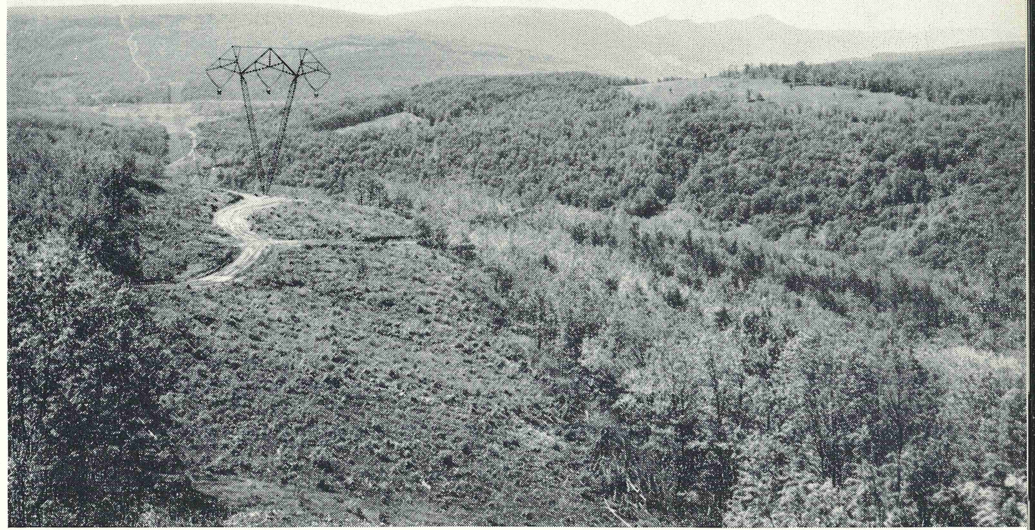



Figure 1

With approximately 200 miles of this rough, wooded terrain to cross, builders of this new 500-kv line give high credit to narrow V-string construction for substantial savings in clearing costs.



As far as the eye can see in this picture, no public thoroughfare runs near the right-of-way. Access is gained by temporary roads, and as much travel as possible is over the cleared section parallel to the line. Never a "picnic," these roads will deteriorate in time from non-use, and make the work of right-of-way maintenance and brush control more difficult and time-consuming. Fewer acres to treat will represent a continuing economy.

# Land saved by V-string construction might make a sizeable ranch . . .

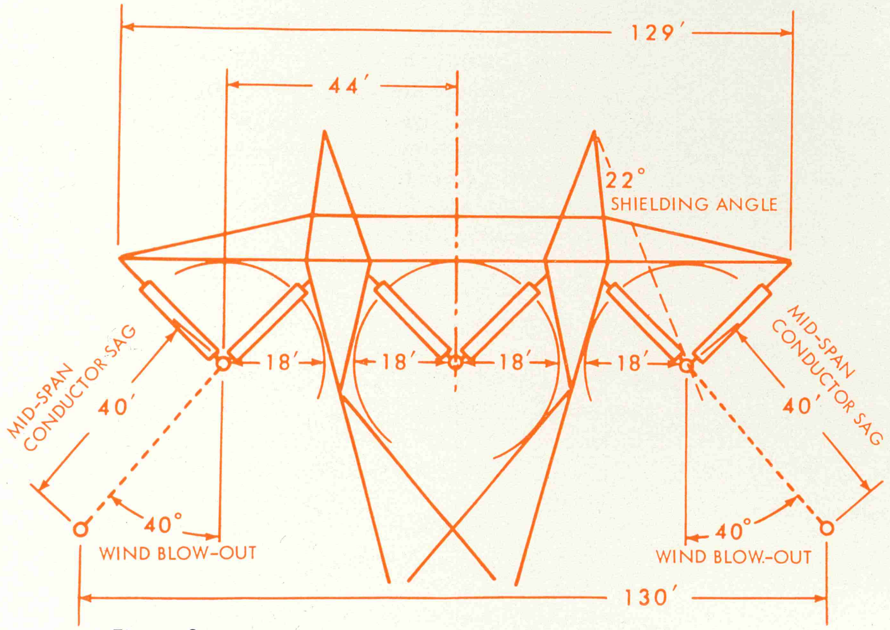



Figure 2

In the April issue of Hi-Tension News we discussed the effect of V-string construction on the cost of towers for an EHV project. Intentionally, the tower we picked to make the point was typical of several currently popular designs. Since the discussion was pointed at tower cost, we only inadvertently mentioned land economies. "Take the same tower and analyze it in terms of real estate," we were asked. We're glad to do this . . . it's our favorite topic!

Tower dimensions are of the ones we used in the illustrations last month. A few cardinal specifications are as follows:

| | |
|---|---|
| Minimum electrical clearance - conductor to structure | 18 feet |
| Shielding angle | 22 degrees |
| Midspan conductor sag | 40 feet |
| Horizontal conductor displacement resulting from wind blowout | 40 degrees |

Both present examples are based on the preceding dimensions. While they do not fully describe a tower, they are the chief considerations in land usage.

In Figure 1, length of the cross-arm is largely determined by the requirement for 18-foot minimum clearance between conductor and tower at a wind blowout angle of 40 degrees. Because the single insulator strings are free to swing in both directions, this results in a particularly wide "window" portion of the tower to accommodate the range of movement of the center phase. Maximum blowout width of the line is 240 feet. The fact that the swinging insulator string on outside phases becomes part of the "pendulum arm" of blowout movement contributes considerably to the line's blowout width.

Going to the V-string example in Figure 2, we start with the basic advantage of conductor restraint at the tower. The 18-foot minimum clearance can be used without any further provision for lateral conductor movement. It will be seen that the 22-degree shielding angle has been retained, but in a more compact arrangement. With V-string construction, length of the insulator string is not a factor in horizontal conductor displacement. Maximum blowout width of this line is 130 feet. Additional clearance to abutting property has been ignored in these examples, since it is a constant that would not affect the analysis.

In Figure 2, 110 feet of right-of-way width are saved. Every eight feet of right-of-way equals one acre per mile; therefore, we have a saving of 13.75 acres of land per mile. If we figure length of such a line at 400 miles, we arrive at a total of 5,500 acres. This is a lot of land to waste needlessly. It would be a good-size "spread" (outside of Texas).

Let us take a critical look at these 5,500 acres. Whether one buys right-of-way, leases it, or obtains an easement right, money for use of land changes hands one way or another. Figuring right-of-way cost at only $200 per acre, we have a saving of $1.1-million. We know of many cases where some sections of right-of-way have cost several times this, and the reader should

*(Continued on next page)*

Hi-Tension News
May 1966, Vol. 35, No. 5

For over 20 years automatic counts have been made of leakage surges occurring on approximately 100 specimens of contaminated, energized insulators in the outdoor test yard of the O-B High Voltage Laboratory. See page 6.

OHIO BRASS CO., MANSFIELD, OHIO

*(Continued from previous page)*
insert his own probable values to arrive at a realistic measure of right-of-way economy.

A prominent 500-kv line, now nearing completion, has a considerable portion of its length traversing rough, mountainous country. Not only are the builders confronted with dense forest growth, but access to many parts of the line is exceedingly difficult, compounded by a serious lack of convenient public thoroughfares. The utility building this line specifically pointed out the important saving V-string construction made in clearing cost.

While it would be unreasonable to assume that every one of the 5,500 acres in our example requires clearing, a normal expectation might be 2,000 acres. Whatever the saving might be, it would still represent a major expenditure that V-strings would make unnecessary.

An economy item that applies to every one of the 5,500 acres saved is the avoidance of continuing maintenance and brush control. As time goes on, and original access roads built for construction deterioriate through disuse, right-of-way maintenance has a way of getting more and more difficult and expensive. But it goes on forever. Acres that don't need attention . . . acres that were never acquired . . . keep saving more money as the years go by.

Lastly, there is a factor, not always applicable, but occasionally capable of becoming a crisis, in planning a new EHV line. Since these lines are naturally long, they see a lot of different territory from end to end. It is quite possible to encounter inescapable restrictions in available right-of-way. While the 110-foot difference in width between Figure 1 and Figure 2 may not always be the answer, there are many times when it can be the determining factor between feasibility and infeasibility.

Since no two lines are alike, and no two territories are alike, it would be unrealistic to promise some specific savings in construction through the use of V-strings. But it would be in line with average experience to anticipate a return expressed in seven figures.

# Proper nozzle often improves insulation cleaning practice

"We don't think we are getting full results with our washing equipment," is a common complaint we hear from utilities that operate an insulator cleaning program. In such cases it often develops that the nozzle is not adapted to the work.

Insulator cleaning with a high-pressure water stream is somewhat more than a flushing action. Most contamination deposits call for a degree of scouring. This is accomplished by water streams at a pressure of 750 psi, or higher, hitting the insulator with considerable mechanical force. If the water stream is broken up on its way to the insulator, a large part of its effectiveness is lost; consequently, the nozzle is all-important. From a distance of 10 to 15 feet, the proper nozzle should deliver a compact stream of high velocity.

Reproduced here is a drawing of a typical jetting nozzle. Main purpose of the drawing is to emphasize the requirements of a proper nozzle, although it could be used as a guide to manufacture if one cared to build his own.

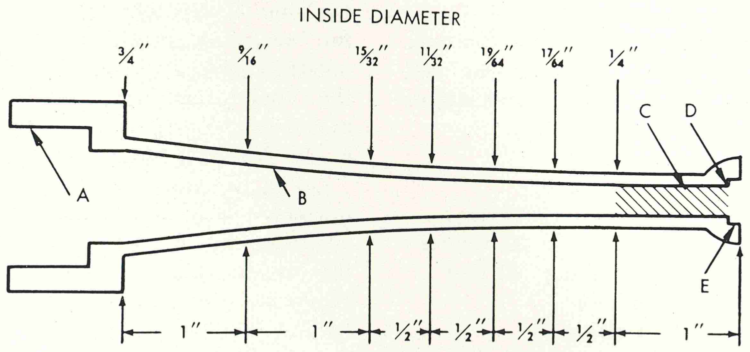
A few points should be noted. Inside finish ("B" on the drawing) while impractical to have highly polished, should be better than the unfinished product of a sand mold. "Commercially smooth" implies a brushed or sandblast surface, or a product made by die casting.

Area "C" on the drawing . . . about the last inch of the interior . . . should be brought to the finest possible surface finish, preferably lapped and polished. Water must pass through this orifice with the least amount of friction. It should also be free from any taper.

Where the polished area terminates ("D" on the drawing), the edge of the opening should be square and sharp. For the last inch the water should pass through a straight section with a minimum of drag, and be cut off clean where it leaves the nozzle. Even a small burr on the tip will start a break in the water stream.

When high-pressure jetting nozzles meet the requirements that have been outlined . . . even though not corresponding exactly to dimensions . . . the insulator will be subject to a high water impact, and much better cleaning results can certainly be expected.

P.S. . .While most nozzles are made of brass and, therefore, would represent a logical product for Ohio Brass, we do not make this line of material. Jetting pump manufacturers often have, or can obtain, proper nozzles. Also, you might contact your local fire chief for the names of high-grade nozzle manufacturing companies.

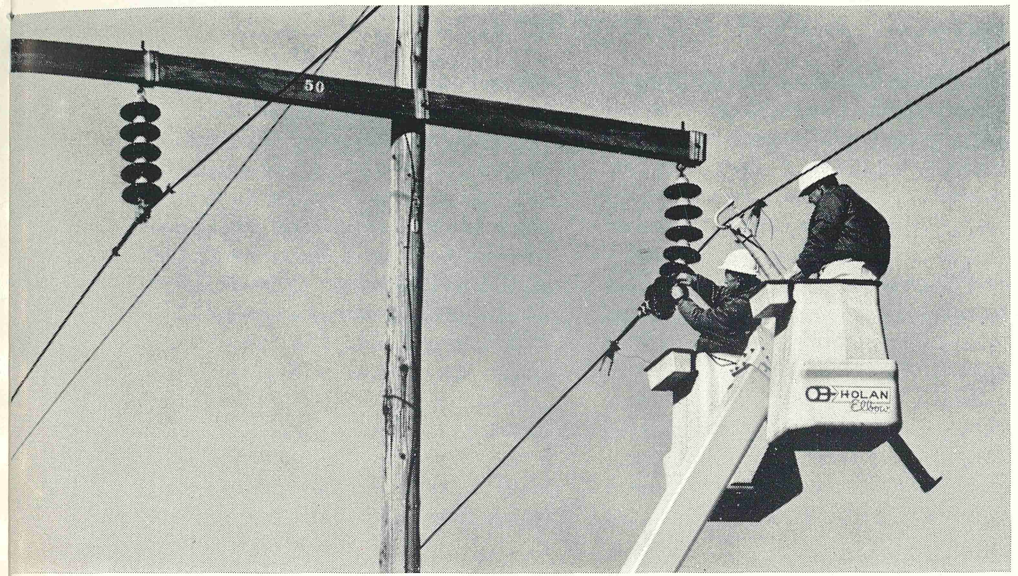


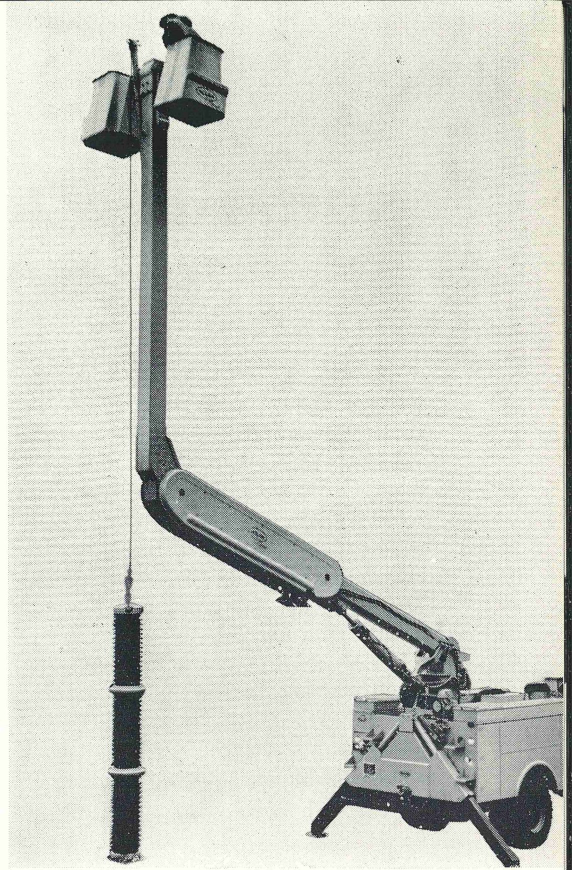

A - ADAPT TO HOSE CONNECTION
B - INSIDE SURFACE COMMERCIALLY SMOOTH
C - LAP TO HIGH FINISH
D - SHARP EDGE FREE FROM BURS
E - PROTECTIVE RECESS



The Holan Bronco 88 Elbow is shown, right, lifting 1300 pounds in an elevated position. Extra material-handling duties can now be assigned, because the Bronco 88 is rated to carry on additional 150 pounds of payload anywhere in range.

One application of the increased working capacity of Holan's Bronco 88 is using the gin pole to do heavy lifting aloft. (below)





# Bronco 88 capabilities boosted 10 to 23 per cent

When can the lifting capacity of a material-handling elbow be uprated? If it's a Holan elbow, only many years of rugged on-the-job applications will prove it can be done without reducing Holan's high standards of operational safety.

For 1966, the field-proved Bronco 88 is available with bare-shaft payload ratings up to 1600 pounds in all positions — even more with the upper arm at higher work angles.

Holan's Bronco 88 stands alone as the only machine in the industry built specifically for material handling — and the only aerial device to prove its cost-saving techniques during years of reliable service. The Bronco 88 is available in two model sizes: the EHV-47 and EHV-52, with working heights of 52 and 57 feet, respectively.

Even in the critical flat-out horizontal position — and equipped with twin buckets and positioning swivels — the EHV-47 lifts two men weighing a total of 500 pounds, plus a maximum payload of 800 pounds. Under the same conditions, the EHV-52 has a maximum material-handling capacity of 650 pounds. These minimum capacity loads may be maneuvered into any position within the aerial flight pattern of the unit.

Material loads of several times higher magnitudes may be handled when the upper arm is elevated into a higher work angle. Users with a knowledge of the exceptional capabilities of the Bronco 88 will not only set new work standards that obsolete regular personnel-carrying aerial devices, but will find that the Bronco 88 elbow will pay for itself faster than any unit on the market.

During the life span of the Bronco 88, your maintenance crews will develop new and more efficient work methods to take advantage of the unit's improved material-handling characteristics. There is no need for early retirement of equipment as new techniques are introduced. The Bronco 88 does more jobs more efficiently — limited only by the amount of imagination applied.

Increasing the lifting capacity of the Bronco 88 adds new dimensions of capability for material handling. But not at the expense of safety and reliability. The constant-radius upper-arm actuation system keeps lifting power within the rated limits throughout the working range. An optional safety overload device instantly stops all movement of the elbow the moment an increase beyond rated capacity occurs as materials are being lowered.

There is more, much more, that distinguishes the Bronco 88 from other aerial units: rugged base frame and stabilizer construction, powerful low c-g "Mono-Race" rotation system, uniformly stressed-beam lower and upper arm construction for maximum strength and low deflection, a dielectrically safe upper arm, and rigid quality control and final inspection. For more information on this performance-proved pacesetter, write Holan, Division of The Ohio Brass Company, Cleveland, Ohio 44135.

# Stiffer new low-voltage apparatus bushings feature strong, compact construction

Class GK-10 through GK-30 low-voltage apparatus bushings now incorporate significant changes developed through O-B's long-range product research activities. The R&D program was specifically directed toward increasing the mechanical characteristics of apparatus bushings in this application range and at the same time more closely aligning their construction with the specifications of the 1964 edition of ASA Bushing Standard C76.1.

Insulation classes for GK-10 through GK-30 bushings are from 15 through 69 kv. No changes have been made in electrical ratings.

The mechanical stiffness and resistance to impact have been substantially increased by reapportioning the weight of all bushings in this group. Moving the center of gravity closer to the bushing mounting flange assures better mechanical performance under the rigorous conditions encountered in circuit breaker applications.

Weight redistribution was accomplished through a number of design refinements. While both length and diameter of the porcelain cone were reduced, changes in its exterior contour retained the same leakage distance. Over-all height of the bushing was shortened by adopting a smaller oil reservoir, the shorter porcelain and a new one-piece aluminum casting to replace the former welded assembly of bushing flange and ground sleeve. Appearance of the new-design GK-30 bushing differs from the former design as shown in Figure 1.

Interchangeable (Breaker-Tran) bushings in each insulation class from 15 through 69 kv now have a new upper end terminal which has the 1½-inch thread diameter specified in the ASA standard, and which can be used in either 400-ampere draw lead or 1200-ampere fixed-conductor applications. Figure 2 illustrates the details of the new terminal. The draw-lead terminal is positioned by the anchoring pin and drawn tight on the conductor extension by the contact nut. The outer terminal, which is the same for both draw-lead and fixed conductor applications, is threaded to the conductor extension.

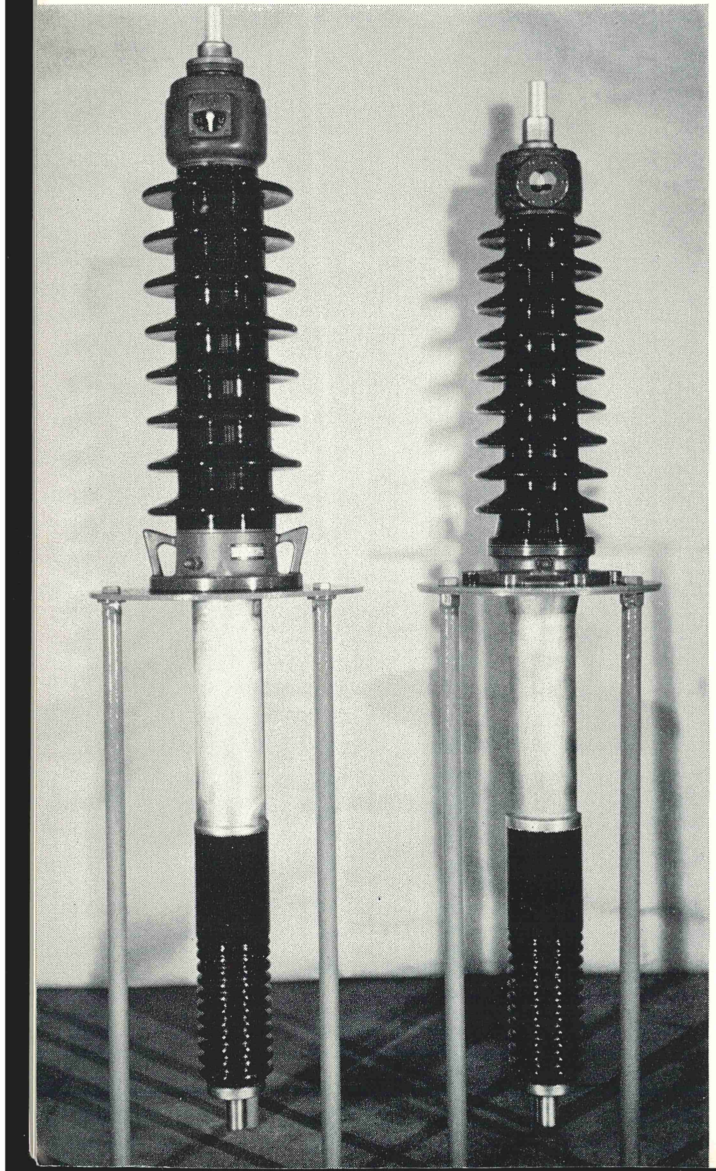


**Figure I**
Comparison of exterior appearance of new-design 69-kv GK-30 bushing (right) with previous design. Changes are in oil reservoir and gage, porcelain cone, terminal, and bushing flange assembly.

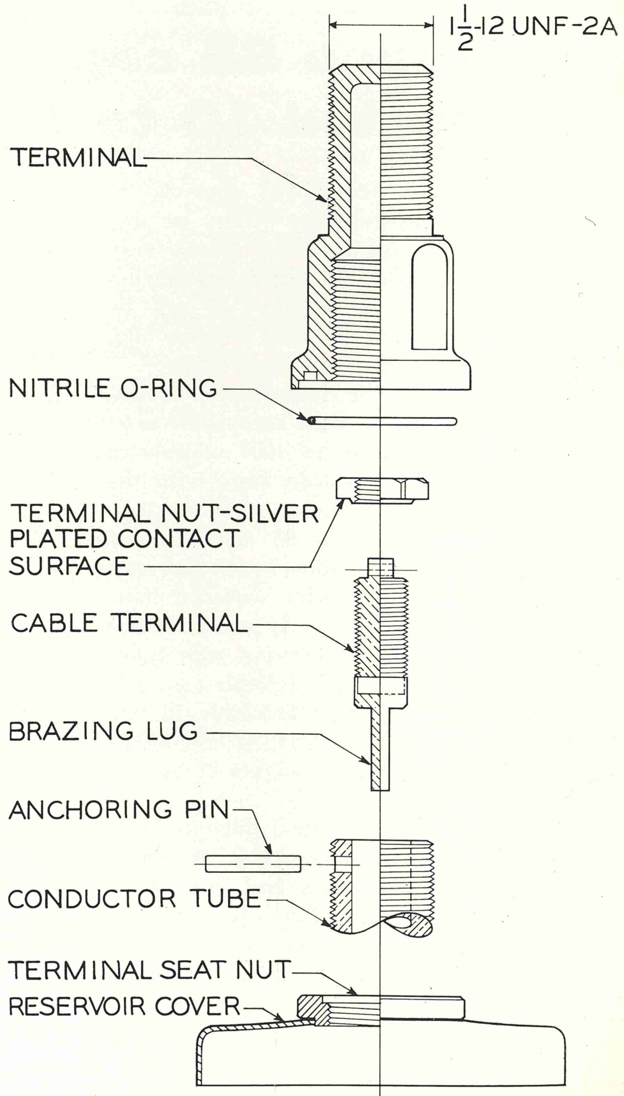



**Figure 2**
Universal terminal for 1200/400 amperes Breaker-Tran bushings. The cable terminal is held in place by the anchoring pin and the terminal nut while the outer terminal threads to the conductor tube extension.

# Changes in 15-kv through 69-kv bushings affect electrical and mechanical characteristics

The sight-type oil gage, which has been standard equipment on 15- through 46-kv bushings for several years, is now furnished on the 69-kv model. This direct-reading gage is designed to read at its midpoint with correct oil fill at 25 degrees C., and is readable over a wide range of temperatures.

Capacitance values for the new-design bushings differ from former models. Factory-measured capacitance values for individual bushings are stamped on the bushing nameplates and provide the basis for comparison of later test values. The tabulation in Figure 3 indicates representative capacitance values applicable to the new bushings. Power-factor limits and the correction for variations in temperature are unchanged from the previous bushing designs.

The new low-voltage GK bushings have successfully passed the exhaustive electrical and mechanical design tests which have been made to assure their full conformance with ASA Standard C76.1. All dimensions, ratings, and characteristics adhere closely to the specifications established by the 1964 edition of this standard.

| O-B Bushing Class | BIL Kv | Insulation Class Kv | CATALOG NUMBERS 400 Amp. 16½" Oil Level | 400 Amp. 21" Oil Level | 400/1200 Amp. Breaker-Tran. | 1200 Amp. 21" Oil Level | Nominal Capacitance pfd. |
|---|---|---|---|---|---|---|---|
| GK-10 | 110 | 15 | 45202 | .... | .... | .... | 587 |
| | | | | 45203 | .... | .... | 710 |
| | | | | | 45205 | .... | 635 |
| | | | | | | 45206 | 710 |
| GK-15 | 150 | 23 | 45222 | .... | .... | .... | 502 |
| | | | | 45223 | .... | .... | 591 |
| | | | | | 45225 | .... | 530 |
| | | | | | | 45226 | 591 |
| GK-20 | 200 | 34.5 | 49201 | .... | .... | .... | 307 |
| | | | | 49202 | .... | .... | 364 |
| | | | | | 49203 | .... | 410 |
| | | | | | | 49204 | 457 |
| GK-25 | 250 | 46 | 49251 | .... | .... | .... | 288 |
| | | | | 49252 | .... | .... | 331 |
| | | | | | 49253 | .... | 393 |
| | | | | | | 49254 | 345 |
| GK-30 | 350 | 69 | 49301 | .... | .... | .... | 232 |
| | | | | 49302 | .... | .... | 267 |
| | | | | | 49303 | .... | 331 |
| | | | | | | 49304 | 345 |

**Figure 3**
Representative capacitance values for GK-10 through GK-30 bushings.

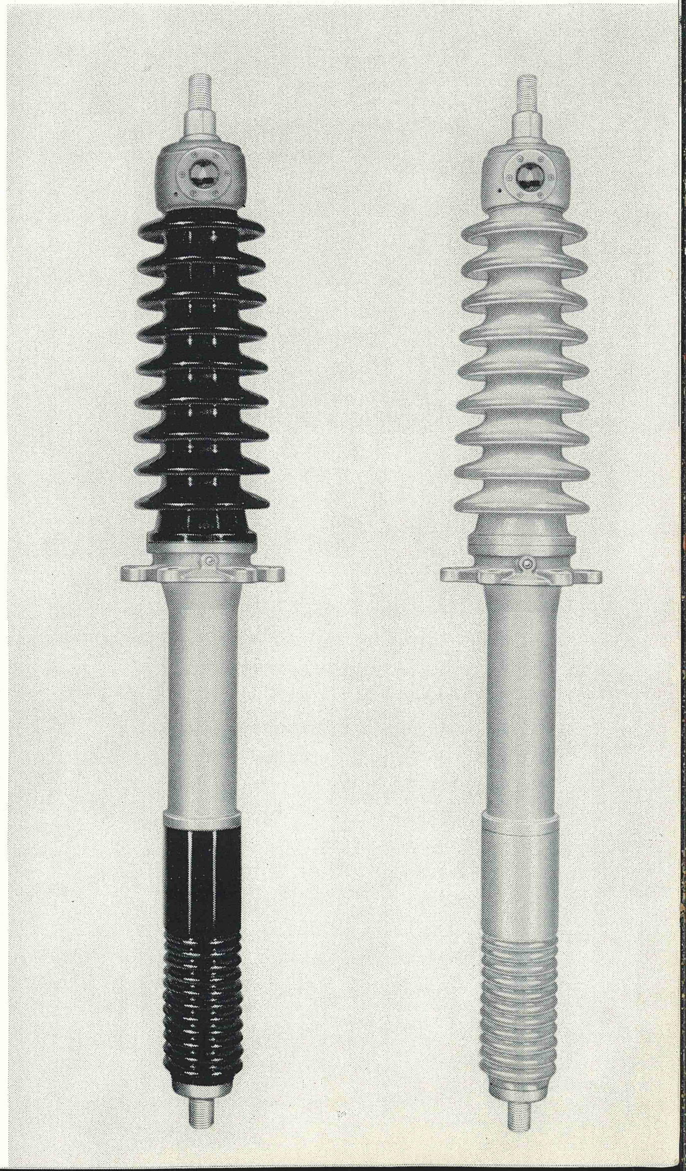
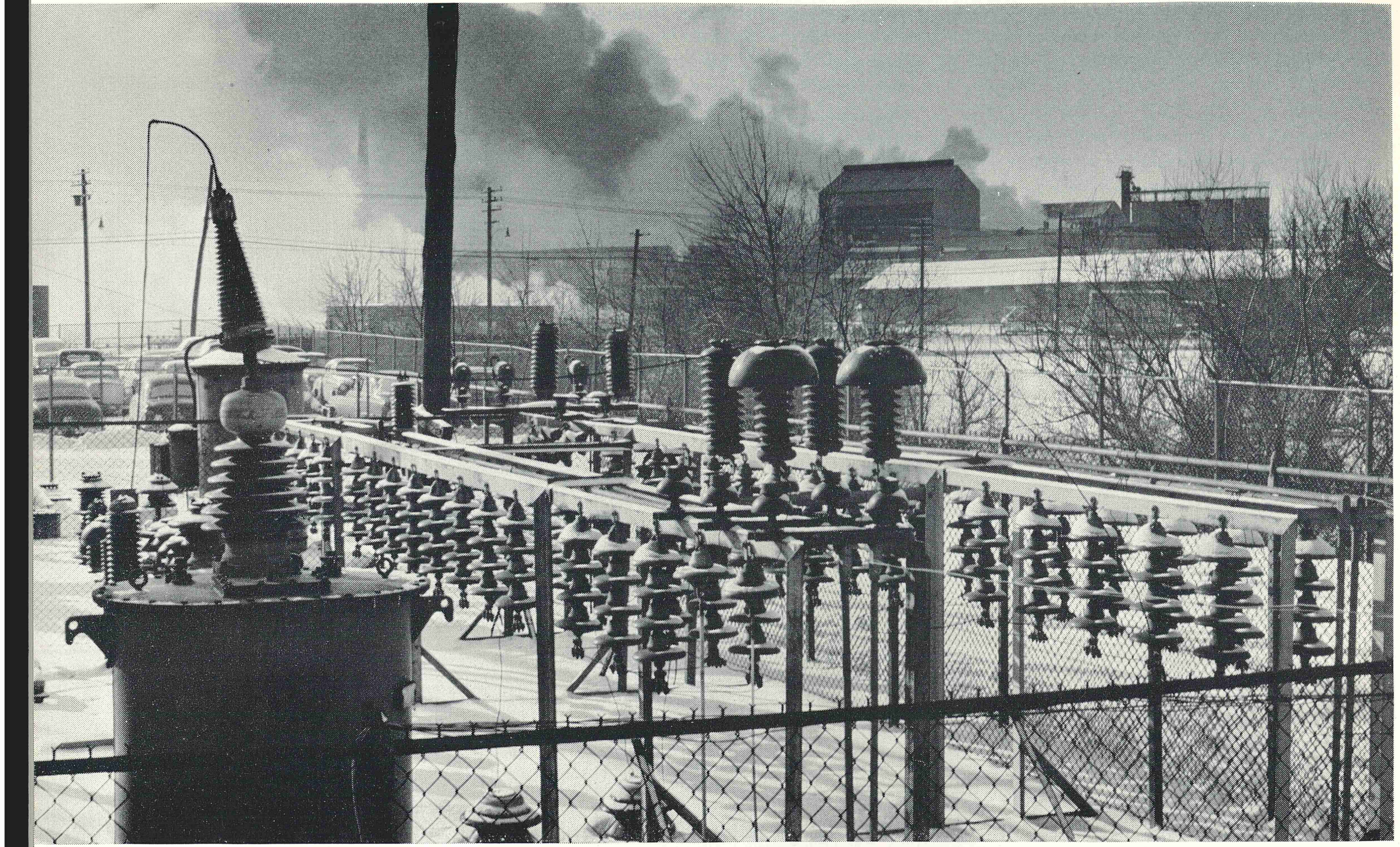
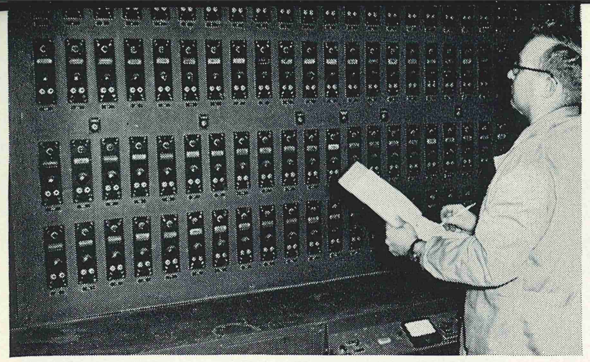


**Figure 4**
GK bushings from 15 through 69 kv can be specified with either Skytone or chocolate glaze.

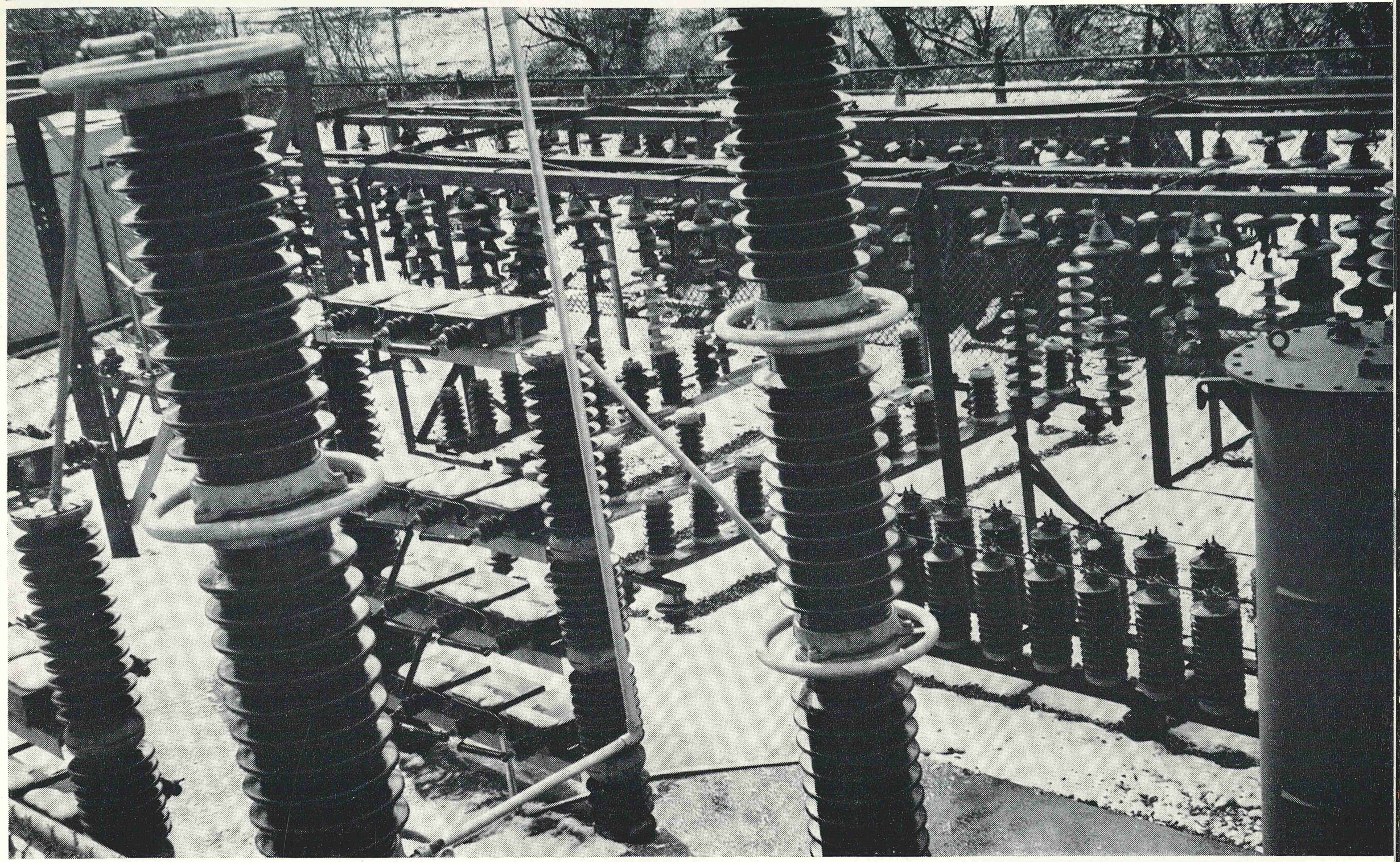
O-B's unmatched "facilities" for contamination studies are well illustrated in this view of part of the outdoor leakage test area. The High Voltage Laboratory is located in the center of an extremely heavy industrial fall-out district.

For over 20 years, row upon row of surge counters have written the story of insulator behavior under contamination. Each specimen is fully energized. Each is monitored by its own counter that records the number of leakage surges.





Insulators of every type are under constant observation in the leakage test area. Contamination is so severe in this locality that few have outlived the 20-year age of the test facilities. A priceless fund of data has resulted from these studies.



# O-B can honestly claim the best "facilities" for contamination studies

## Start with our location in one of the heaviest industrial fall-out areas

For over 20 years the outdoor exposure racks in the O-B High Voltage Laboratory have been providing practical answers on the subject of insulator contamination. Hundreds of specimens are constantly under observation.

In a sense, we are "fortunate" to have such an excellent location for contamination studies. The immediate section of Barberton, Ohio, where the O-B plant is located is considered to be one of the most severe industrial fall-out areas in the state. Smoke, clouds of polluted steam, and a variety of chemical wastes drift over the O-B test yard from a huge adjoining chemical plant. From only a little farther away, a foundry contributes a rich brown pall, well laden with air-borne contaminants. Keeping our outdoor electrical test equipment clean is a constant battle, but for a program of contamination research, we couldn't find a better place if we tried.

Each specimen in the fenced-off test area is continuously energized. Since electrical surface leakage is of a surge character, this makes it possible to connect specially constructed automatic surge counters to each specimen and thus get an accurate picture of its leakage behavior. No one was disposed to go back over 20 years of voluminous records and add up the number of surges that have been recorded on hundreds of counters, but a fair estimate would run into the millions.

## . . . then add excellent research methods

From time to time, as contamination builds up to the point of flashover, specimens are changed out and new tests are started. Most insulators have not survived the full 20 years this study has been in progress. This is a desirable condition. It is like being able to test a product to destruction. You discover its ultimate characteristics.

This project has proved exceedingly fruitful. It provides an absolutely practical basis for evaluating contamination behavior of various O-B insulators, as well as other makes. Occasionally it debunks a trick design. It gives you a secure background of facts to recommend one insulator shape over another when you are confronted with a contamination problem.

So, today while you read this, and tonight while you sleep, fully energized insulators exposed to severe contamination are writing their separate performance histories on hundreds of surge counters in the O-B High Voltage Laboratory. For over 20 years they have been doing this. The result is a background of experience and data unique in the industry. You are urged to call on this fund of information if confronted with a contamination problem. Our accumulated knowledge relative to the action of certain types of insulation under severe exposure may be of considerable assistance.

# Of all intermediate arresters only one has the current-limiting series gap!

## O-B's exclusive GP Dynagap construction establishes new, higher levels of performance characteristics

Can you ever afford to settle for less than the best available in any lightning arrester installation?

If your answer is, "No," then let us remind you that Ohio Brass GP Thorex lightning arresters are the only intermediate class arresters which incorporate the powerful current-limiting series gap similar to those used in the industry's most capable station-grade arresters. Because of this gap, the high standards of protection set by GP Dynagap arresters are comparable to most modern station-class models.

Current-limiting-gap construction has head-and-shoulders superiority over any other form of arrester construction known. In the 10 years since O-B first introduced the Dynagap principle, all major arrester manufacturers have developed their own versions of the current-limiting gap for their station class models, but only Ohio Brass has provided this advanced operating feature in its line of intermediate arresters.

The big and significant advantage of current-limiting-gap arresters is that they do not have to wait for system voltage zero in order to achieve power-follow current interruption. The oscillograms of Figure 1 illustrate first in (a) the conditions which exist in an arrester with conventional series gap interruption, and then in (b) the dramatic improvement which is accomplished with the Dynagap action.

With 60-cycle voltage applied to the arrester, an impulse surge is discharged through the arrester at approximately 30 electrical degrees past system voltage zero. In the conventional arrester (a) power-follow current continues to flow through the arrester to ground until the system voltage reaches its next voltage zero — 150 electrical degrees later. In the Dynagap arrester, under the same impulse discharge conditions, (b) the current-limiting-gap effects power-follow current interruption within 35 electrical degrees after initiation of the surge, and thereby limits the flow of the follow current to a fraction of that permitted by the conventional gap.

Broad, substantial benefits to the basic arrester operation come from the fast Dynagap interruption of the power-follow current. Performance characteristics of the GP intermediate arresters are so markedly improved over conventional arresters that customary industry standards can only partially reflect their inherent superiority. Since the current-limiting gap relieved the valve blocks of a major portion of their original function of restricting the flow of power-follow current, subsequent O-B research into valve block technology has successfully developed much more favorable characteristics of impedance, durability, and thermal capacity.

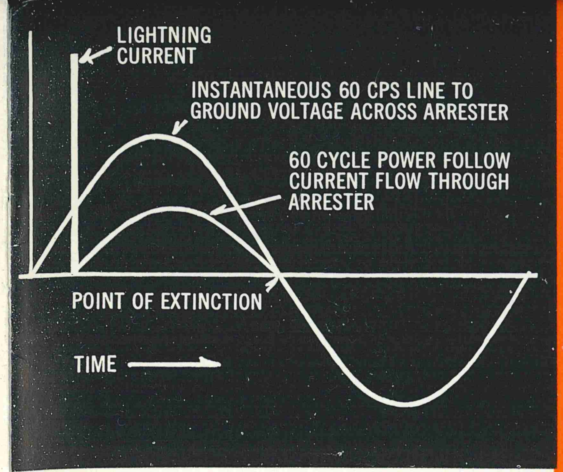
Reapportionment of duty within the arrester has thus produced significantly lower IR discharge voltages, greatly increased durability to multiple strokes and repeated operations, and expanded capacity in discharging high energy overvoltage surges.

Even the most cursory engineering evaluation of GP Dynagap intermediate arresters can prove without question the improvement that can be obtained in the protection of essential equipment. Insulation levels can be maintained by much greater safety margins, spark-over voltages can often be reduced, weak or damaged insulation (old or new) can be given a much better chance of survival, and installed arrester protective systems can be relied on for long-time serviceability under heavy duty conditions. Field performance of GP intermediate arresters since 1957 has indicated far fewer failures than are normally expected with the severe operating requirements frequently imposed on lightning arresters.

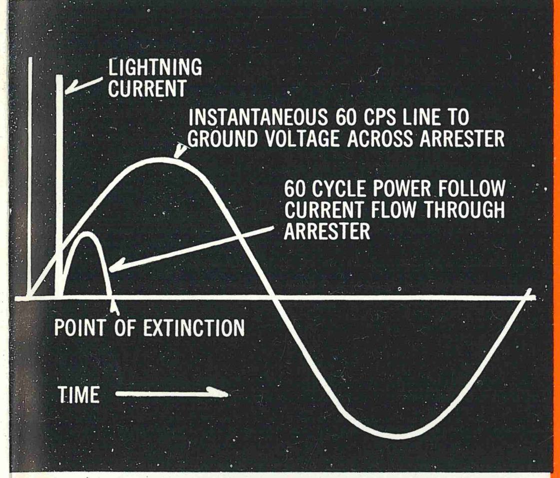
The current-limiting series gap has been incorporated into the Ohio Brass GP intermediate arrester without increasing its cost over comparable conventional gap intermediate arresters. Wherever conditions warrant the installation of intermediate arresters, the superior performance characteristics of the conservatively rated GP's are an important bonus value in greater safety margins, increased thermal capacity and improved durability.

And remember, in every case you get a full - sized modern-design arrester. Ohio Brass GP arresters are built in the finest wet-ware porcelain housings with heavy hot-dipped galvanized malleable iron base castings and your choice of either metal or porcelain top closures. Housings are evacuated, inert-gas filled, and then permanently sealed for complete weatherproofing. All models are equipped with O-B's highly developed pressure-sensitive, pressure-relief system. Installation is simple and requires only a minimum of time and equipment.






Oscillogram (a)




Oscillogram (b)

**Figure 1**
Current - limiting gap interrupts power follow current independently of system voltage zero.

(Upper) Lightning surge discharge through intermediate arrester having conventional series gap.

(Lower) Lightning surge discharge through GP Dynagap intermediate arrester with current - limiting series gap.

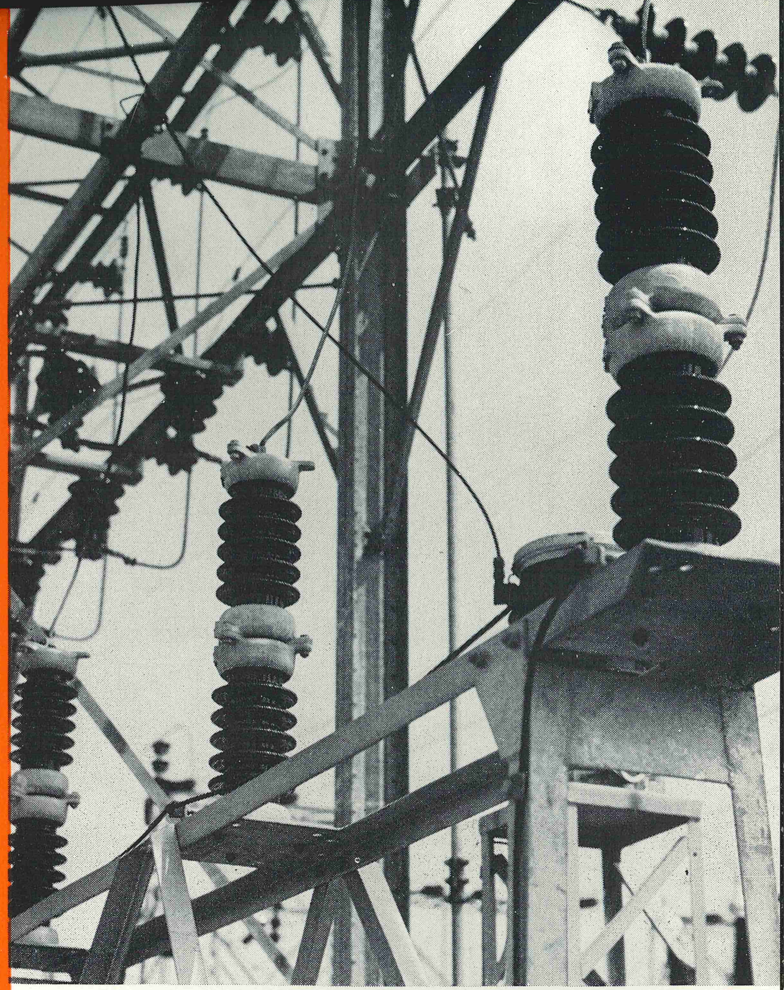


**Figure 2**
Ohio Brass GP - 40 Thorex Dynagap intermediate class lightning arresters installed in 46-kv substation.

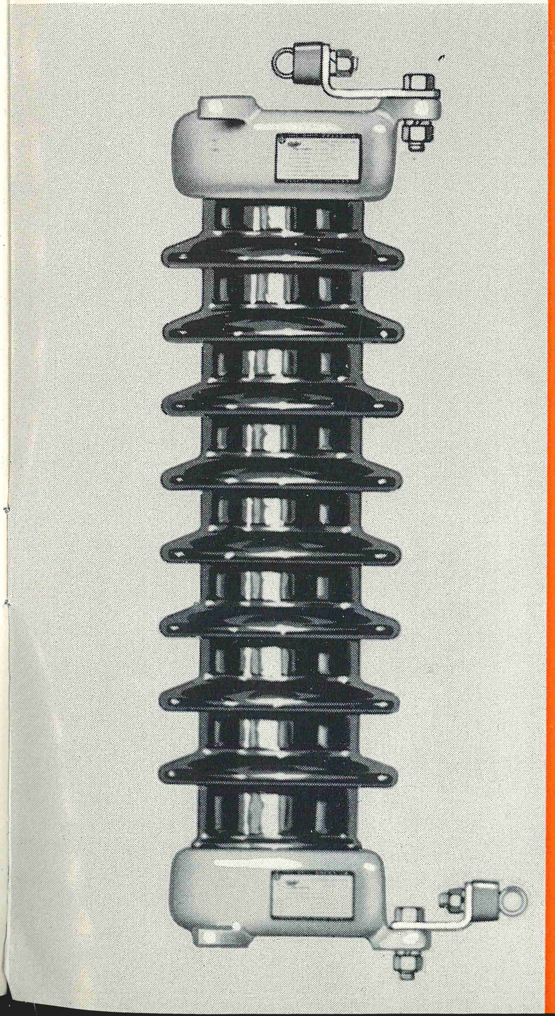


**Figure 3**
GP-30 Dynagap intermediate arrester is only 27 inches high and weighs approximately 76 pounds. GP arresters are made in ratings from 3 through 120 kv.

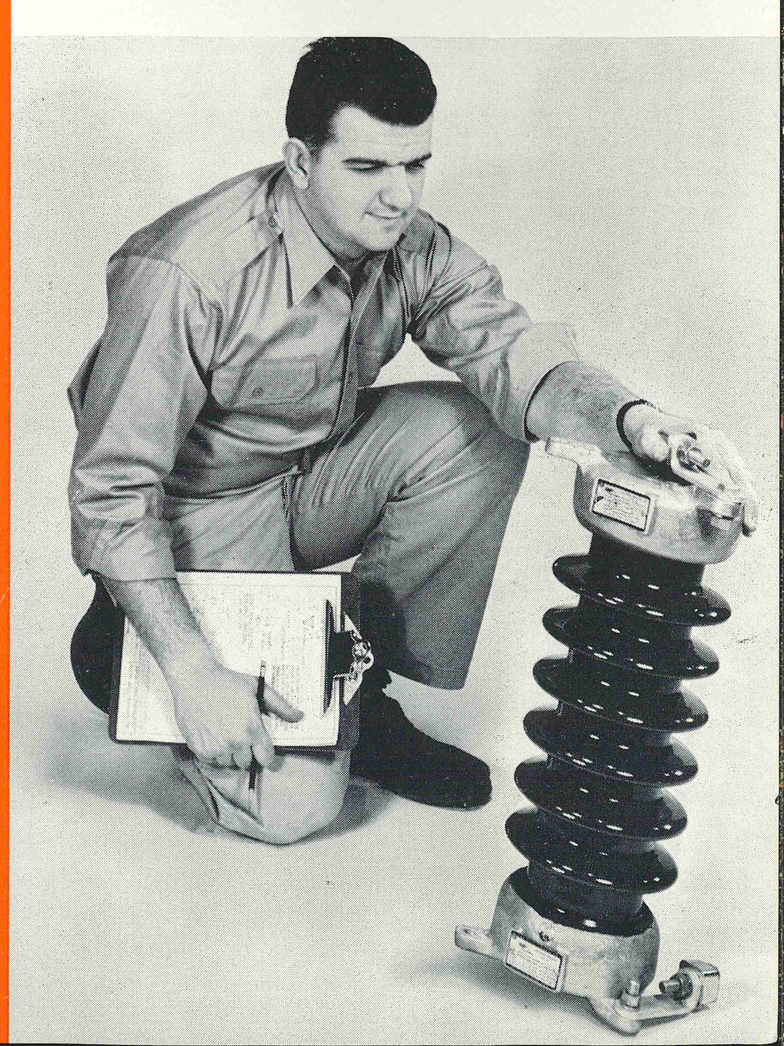
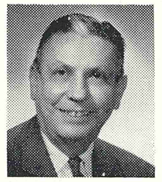


**Figure 4**
The compact, conservatively - rated GP Dynagap intermediate arrester provides the industry's best protective characteristics in numerous applications where the versatile operating refinements of the modern station class arrester cannot be economically justified.

**OHIO BRASS MANAGEMENT REPORT**

# Words on a "sorry" attitude and how to stamp it out, maybe

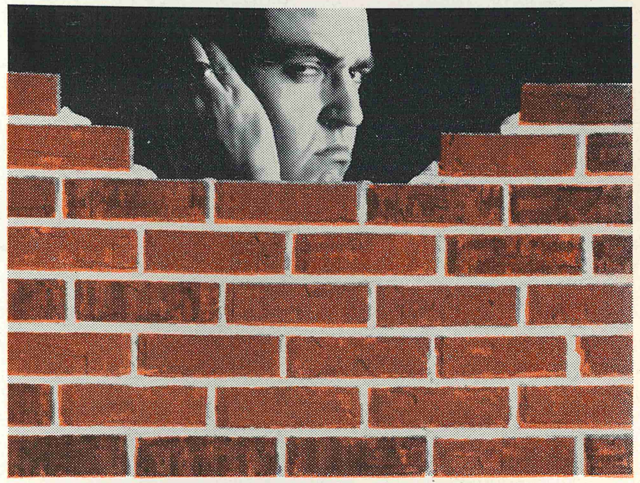
**BY ROGER A. BLACK**
PRESIDENT, OHIO BRASS COMPANY



"I'm sorry, but that's not my department." The words may be different, but the attitude that goes with them is always the same. If management could stamp out this attitude, think of the wonders that would be accomplished. Financial men might become more tolerant of production and engineering people and more understanding of the salesman. The engineer would explore the wonders of the market place. In an industry beset by shortages of materials and tempers, buyer and seller could switch positions and discover that the other fellow is still trying to do the best job he can.

**AT OHIO BRASS** our products and associations with the utility industry have expanded to the point that the company and individuals in the company can't afford "not my department" thinking.

**CONSIDER A FEW** of the improbable things that aren't exactly "in our department." Sixteen years ago we had to delve deeply into the theory and construction of transformers when we introduced a lightning arrester for the protection of such equipment. And since arresters dealt with lightning, some men even sought a greater knowledge of meteorology. We developed an active interest in real estate values when we began promoting V-string construction for the conservation of right-of-way. We became highly conscious of public relations when we started working on radio-silent insulation.



**IT WOULD TAKE** comparatively simple, inexpensive equipment to prove that an insulator meets published catalog values. But we have assigned acres of valuable land to laboratories and spent millions of dollars on elaborate testing equipment to put those insulators on full-size towers, supporting their proposed conductor system, in a realistic outdoor environment where test answers are most dependable . . . but towers and conductors are not "in our department."

**PERHAPS THE SOLUTION** lies in a proper answer to: "What is our department?" As long as an O-B product is involved, THAT IS our department. 748-H

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

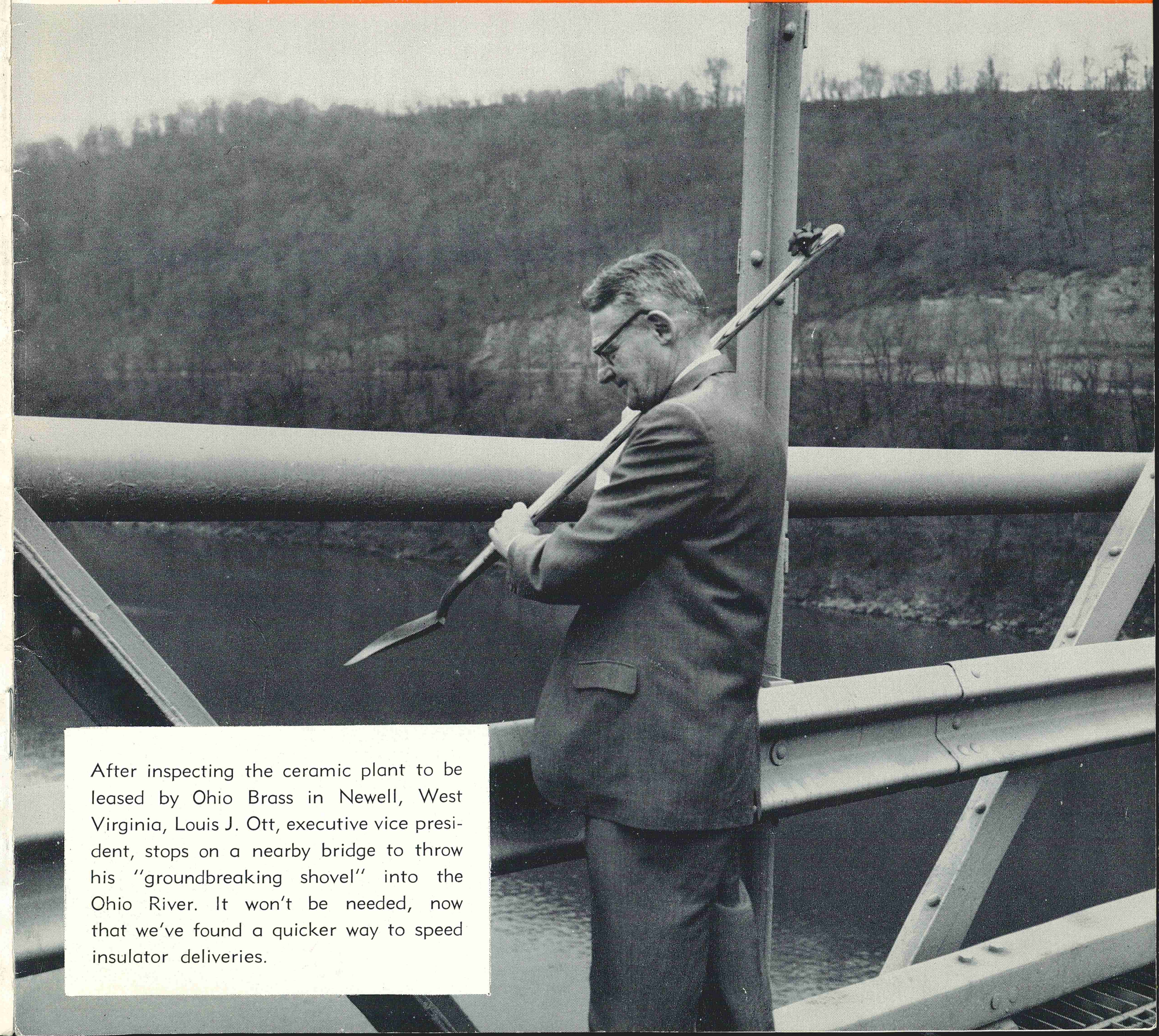
OHIO BRASS

June, 1966, Vol. 35, No. 6

6666-H

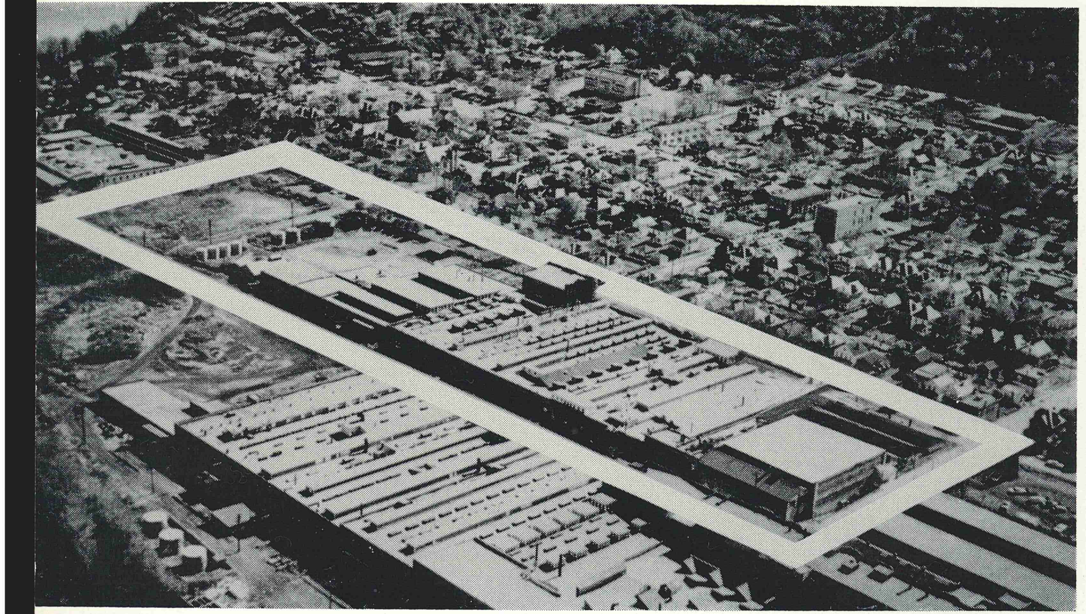
Hi-Tension News

JUNE 1966



After inspecting the ceramic plant to be leased by Ohio Brass in Newell, West Virginia, Louis J. Ott, executive vice president, stops on a nearby bridge to throw his "groundbreaking shovel" into the Ohio River. It won't be needed, now that we've found a quicker way to speed insulator deliveries.

# O-B LEASES LARGE FACILITY FOR EXPANDED INSULATOR PRODUCTION



Aerial view of the 356,000-square-foot plant which will be converted as rapidly as possible into expanded manufacture of O-B insulators. Well over a year of construction and organization have been by-passed with the acquisition of this large ceramic plant.

Down from a bridge went a brand new shovel into the Ohio River. Our executive vice president, Louis J. Ott, had been presented with this shiny ceremonial shovel by one of our good customers to use in a groundbreaking celebration. We had been ready to build a new factory to increase O-B insulator production. But the shovel wasn't needed. In lieu of a new building that would take well over a year to erect, we now have 356,000 square feet (eight acres) of immediately available space for expanded insulator manufacture. After inspecting these facilities and appraising their immediate potential, our vice president disposed of his groundbreaking shovel with no regrets!

O-B has leased the entire plant of what was formerly the Edward M. Knowles China Company of Newell, West Virginia. This plant was originally built for ceramic manufacture and admirably fits our requirements for insulators. Probably its greatest asset, under present circumstances, are two large continuous kilns in excellent working condition. Having them available will cut as much as a year from the time needed to get the plant into operation, and will add over 33 per cent to O-B's total kiln capacity. These kilns will facilitate porcelain production as quickly as machinery can be obtained and set up.

First step in the utilization of this plant, and one which can be put into effect almost at once, is insulator assembly.



Even more important — immediate steps will be taken to install complete and greatly enlarged post production facilities.

O-B has been investigating every possible means of increasing insulator volume, with the element of time the foremost consideration. It has appeared infinitely preferable to move into an existing building, ready to accommodate production, rather than to start with a mere hole in the ground.

Another very important factor relates to the location of this plant. Newell and Chester, West Virginia, are across the Ohio River from East Liverpool, Ohio. Centering in this area and extending south down the river, is the heart of the Nation's ceramic industry. Competition has forced many companies out of business. Therefore, skilled ceramic workers are available who can give us increased production with a minimum training period.

First official greeting to plant visitors is performed by the newly appointed manager, Arnold F. Kozlowski (left), at the office reception desk. His guests are Louis J. Ott, executive vice president, and Estes C. Thompson, vice president, manufacturing, of Ohio Brass.

Newell's location of only 75 miles from Barberton and 125 miles from Mansfield, means overnight shipment between plants and convenient access for technical and production personnel.

Speaking frankly to the buyers and users of O-B insulators, no matter how happy they may be in seeing some tangible relief for present extended delivery problems, we are equally gratified. The hardest thing a supplier must do is say "no" to an order. While our customers have been remarkably tolerant and understanding, there is little satisfaction in seeing a "tolerant and understanding customer" buy his materials from someone else . . . especially outside the United States. We sincerely believe this large expansion of O-B production will have a noticeable and early effect on insulator supply.

Almost priceless assets in the plant, originally occupied by the Edward M. Knowles China Company, are two large continuous kilns in fine operating condition. This will permit early production, contrasted to perhaps a year's delay, and adds over 33 per cent to O-B's total kiln capacity.

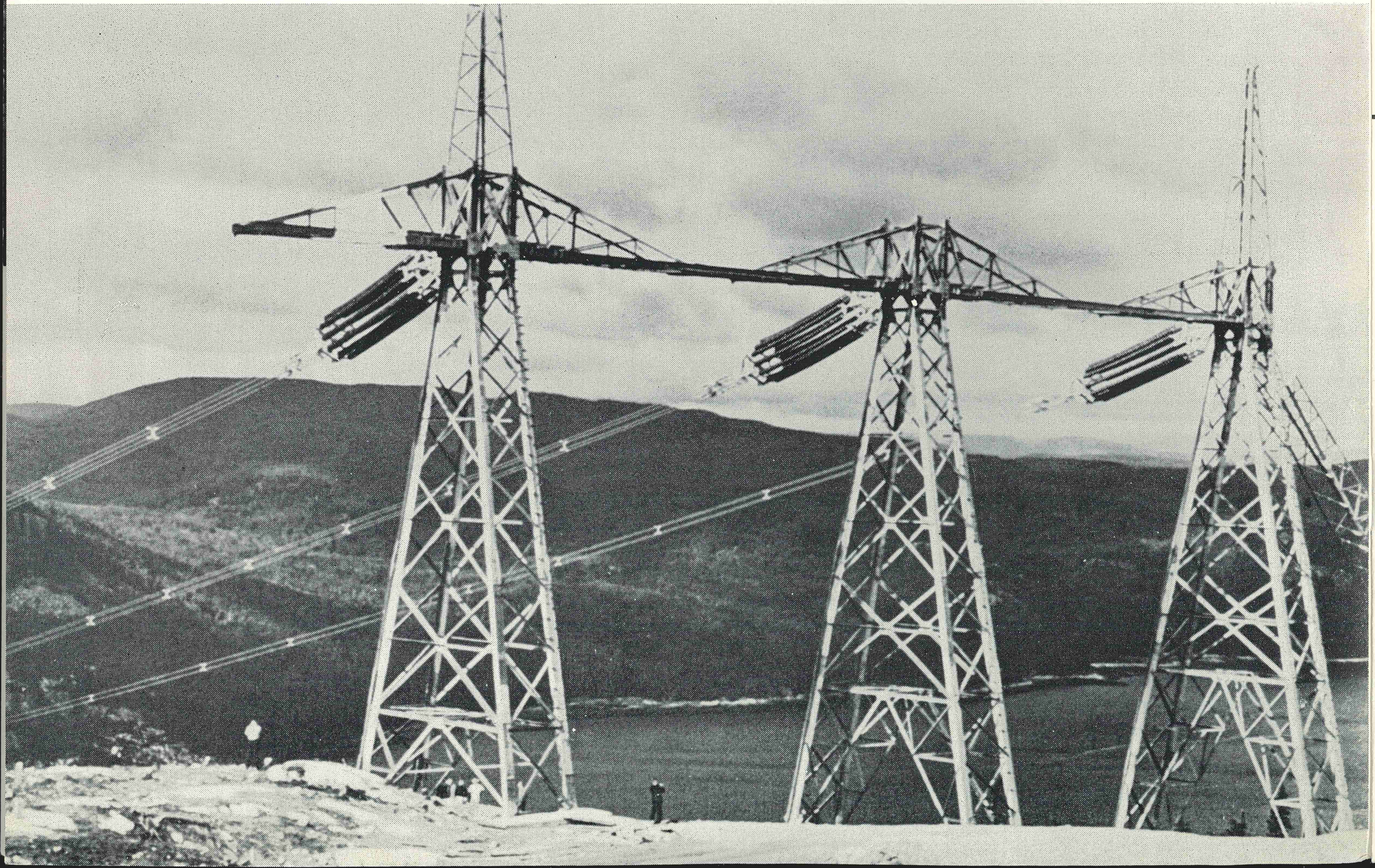
# Specification of EHV deadend equipment simplified by full assembly catalog numbers

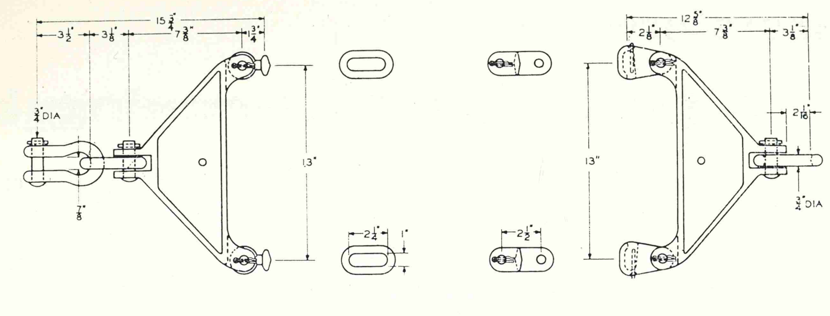
As a major supplier of construction materials, we see increasing evidence that EHV projects involve a higher proportion of heavy deadends than existed in the day of more conventional voltages. The tendency to build generating plants adjacent to supplies of fuel and water often calls for long distance transmission, frequently over rough terrain. Large valleys or waterways are a normal expectation in the size and nature of territory involved. Therefore we commonly encounter long crossings.

Tensions on these long spans are magnified by the diameter and number of sub-conductors per phase. This not only increases static weight but also has a profound effect on ice and wind loadings. Therefore, where a deadend is needed, it is often a heavy piece of construction. Possibly the greatest mechanical load so-encountered is the 6,900-foot crossing of the Saguenay River on the 735-kv Hydro-Quebec project. Here, each phase consists of four 1.1-inch steel cables. Ultimate strength of deadends is 600,000-pounds per phase. Expected load on each phase is 260,000 pounds with ice and wind. And on the Saguenay, ice and wind easily justify the term "expected."

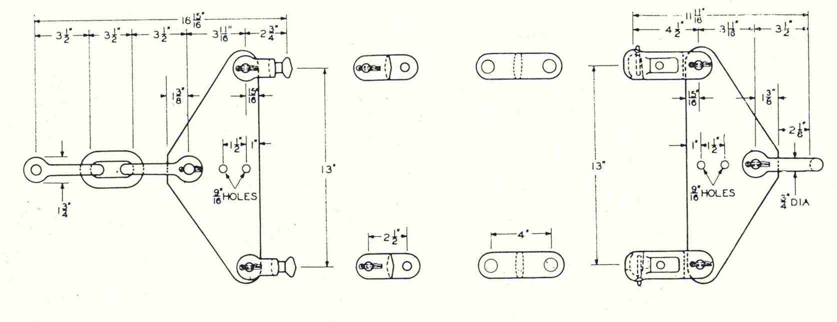
Designers of EHV lines may be aided by a review of O-B deadend assemblies. These are illustrated and rated for strength. Such assemblies are supplied complete under a single catalog number, with all parts and fittings included. Special combinations for unusual duty often involve certain exceptions or custom design, and naturally do not lend to being cataloged. Insulators are not shown because of their range in choice of strength. Many engineers prefer to use insulating members with a considerable surplus of rating to keep safety factors high in their deadend construction. Therefore, insulator specification is left to the user.

Ultimate strength of each phase in this massive deadend is 600,000 pounds, making a total of 1,800,000 pounds for the structure. Four 1.1-inch steel cables per phase cross the Saguenay River with a span of 6,900 feet on this 735-kv project.

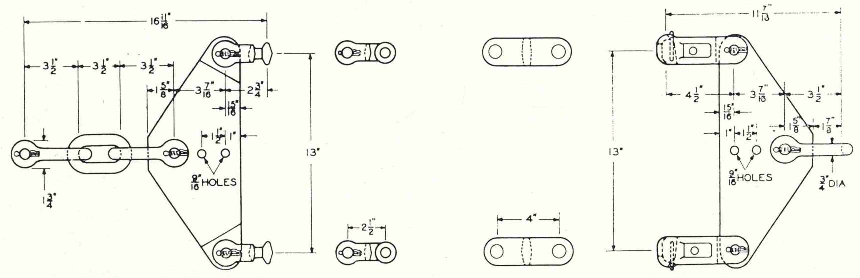




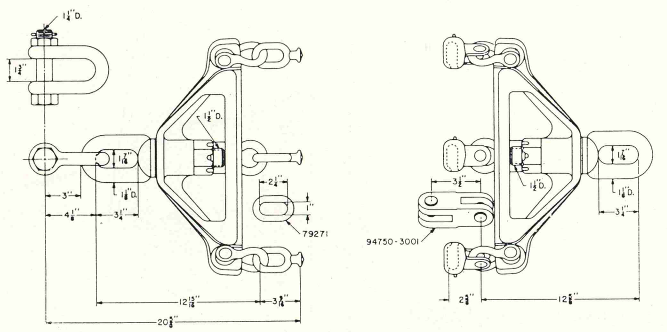
For light duty, this two-string assembly with malleable iron yoke plates has an ultimate strength rating of 25,000 pounds. Equipped for ball-socket insulators it carries a Catalog Number of 79680. For clevis-type insulators use Number 79681. Alternate fittings for the two types of insulators are illustrated.



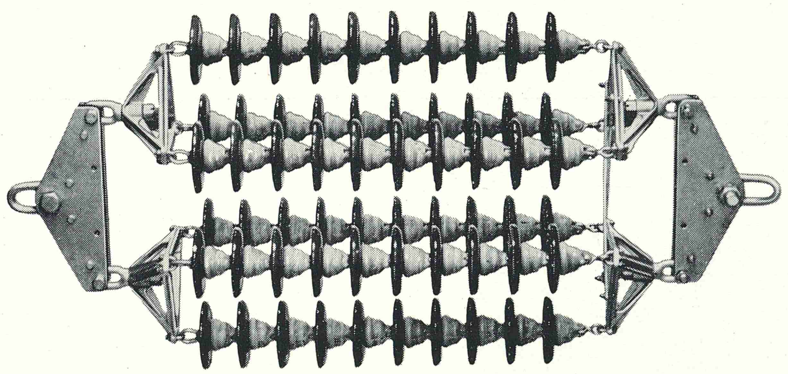
Medium duty construction utilizes a steel yoke plate that increases the ultimate strength rating of this two-string assembly to 36,000 pounds utimate. For ball-socket insulators specify Catalog Number 79631. If clevis-type insulators are used, the Number is 79632. All parts of all assemblies shown are heavily protected with galvanizing.



For two insulator strings in heavy duty service, this steel yoke plate assembly has an ultimate strength of 60,000 pounds. For ball-socket insulators, the Catalog Number is 79633. For clevis type the Number is 79634. With any of the preceding assemblies, two or three can be combined for higher ratings.



Three strings of insulators are used with this extra-heavy assembly rated at 90,000 pounds ultimate. The ball-socket version carries Catalog Number 79697. Clevis type is Number 79698. A practice gaining in popularity, where strains are high, is to deadend each sub-conductor independently rather than deal with strain on the total bundle. A similar assembly is available in a 110,000-pound ultimate strength rating, with insulator strings on 18-inch centers.



This six-string assembly is typical of many multiple deadend arrangements. A triangular master yoke would permit use of nine strings if desired. In such cases, ultimate strengths would be 180,000 or 270,000 pounds, respectively. Master yokes are supplied on special order, as they frequently involve custom design.

## O-B's High Voltage Laboratory:

# Aims for specific targets in programming high-voltage impulse tests

### Expert manipulation of huge surge generator produces front-of-wave, chopped-wave, and full-wave withstand values

Determination of insulation withstand voltages for various electrical components such as suspension insulators, posts, pincaps, bushings, and similar equipment requires separate and different testing procedures to investigate the impulse and continuous (or 60-cycle) insulation strengths. The O-B High Voltage Laboratory has the complex, specialized surge generators which enable its staff of research engineers to conduct the high-voltage trials required for complete evaluation.

Impulse testing establishes the ability of a specimen to survive anticipated overvoltage surges. These surges can appear on the line as a result of lightning, switching operations, or other transient disturbances. They are characterized by their comparatively short duration and by voltage levels far above normal operating conditions.

The wave form of overvoltage surges becomes an important factor in the investigation of insulation withstand strengths. The wave front defines the rate of increase of voltage in respect to time, while the wave tail indicates the duration of the surge. Statements of impulse withstand strength must, therefore, define both the wave shape and voltage of the applied test surge.

Overvoltage surges may occur in an infinite variety of wave forms, ranging from extremely steep front lightning surges of very short duration to the switching surges with their typical slow-rising fronts and substantially longer durations. Under such conditions industry has elected to use the easily reproducible 1.2 x 50 microsecond wave as its standard for impulse withstand-test procedures. The 1.2 x 50 microsecond wave (Figure 1) is defined as having a crest voltage which is reached in 1.2 seconds and a wave tail which decays to ½ crest value in 50 microseconds.

Impulse test procedures use the 1.2 x 50 mu-sec voltage wave to determine a series of characteristics relating to the specimen which can then be consolidated to establish the impulse insulation withstand strength. The test series consists of three groups of trials by which values are obtained for full-wave withstand, chopped-wave withstand and usually for front-of-wave withstand. Each of these tests is accomplished by variations in the procedure by which the impulse generator applies the high-voltage surges to the specimen. Figure 2 illustrates a typical impulse flashover on stacking posts supporting an air break switch. Many consecutive trials must be made in order to establish the final test values. Results are normally displayed in the form of a curve (Figure 3) which delineates the front-of-wave, chopped-wave and full-wave withstand voltages as a function of time.

Sequence of testing normally consists of completing the full-wave withstand trials before initiating the chopped- and front-of-wave tests.

The full-wave withstand voltage test applies the 1.2 x 50 mu-sec voltage wave in its entirety to the specimen. The value reported is the maximum voltage which causes no flashover. Figure 4 illustrates a simplified diagram of the impulse generator circuit as connected for making full-wave voltage tests. Full-wave withstand strength of equipment is commonly referred to as the basic impulse insulation level (BIL), a widely used term which defines the crest value of the impulse voltage which electrical equipment is required to withstand without failure or disruptive discharge.

In the chopped-wave test, an external air spark gap is added to the generator test circuit and connected in parallel with the specimen as shown in Figure 5. This gap is adjusted before tests are made so that the impulse voltage will flash over to ground at a definite time interval measured from the beginning of the test wave. The crest voltage of the chopped-wave impulse test is substantially higher than that established by full-wave testing, since the insulation of the specimen has a greater withstand strength in respect to the shorter duration of the impulse wave.

Front-of-wave testing is similar to that of the chopped-wave-test procedure, since the same circuit diagram of the impulse generator is applicable. In front-of-wave testing, however, the impulse wave is chopped by action of the parallel gap while the voltage is still rising to its crest value. Since the duration of the application of the impulse surge to the specimen has again been significantly reduced, the value of the voltage reported for front-of-wave withstand will be higher than either that of the full-wave or chopped-wave tests.

Proper application of BIL values in studies of system insulation coordination constitutes a systematic method by which improved system reliability can be obtained at substantially reduced insulation levels. The basic coordination diagram (Figure 6) illustrates the relation of the lightning arrester's impulse protective level to the equipment insulation withstand voltages. Recommended practice is to select first an arrester rating which is known to be capable of interrupting power-follow current under anticipated dynamic system overvoltages. Application of the appropriate protective margin then determines the lowest suitable BIL for station equipment. The opportunities for one-, two-, or even three-step reductions in the equipment BIL have saved millions of dollars in the cost of insulation of major electrical apparatus.

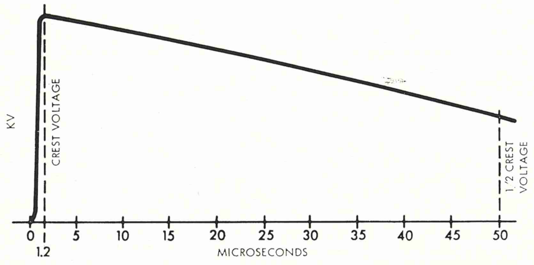



**Figure 1** — Standard impulse test wave (1.2 x 50 mu-sec) rises to crest voltage in 1.2 microseconds and decays to ½ crest voltage in 50 microseconds.

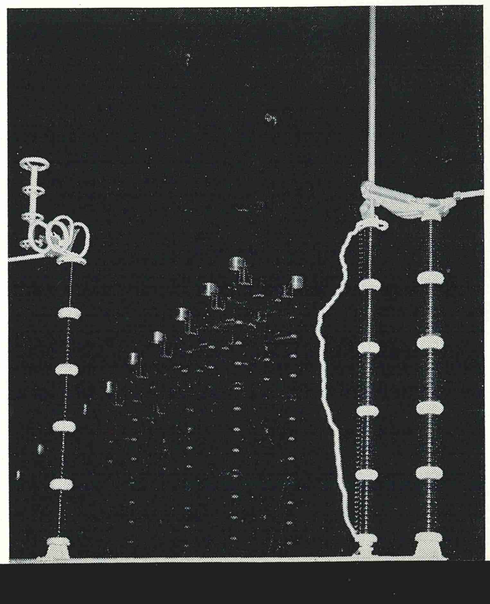


**Figure 2** — Impulse testing of air break switch insulation produces exterior flashover.

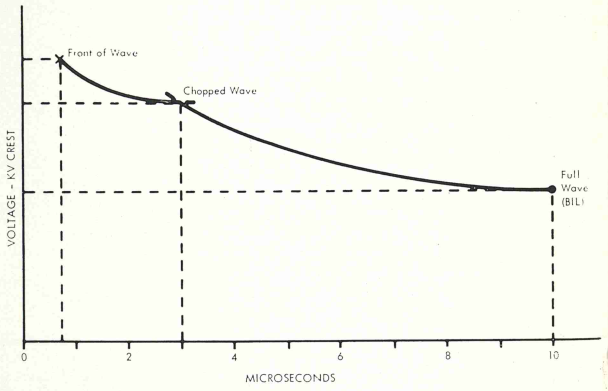



**Figure 3** — Impulse insulation withstand curve showing front-of-wave, chopped-wave and full-wave test values.

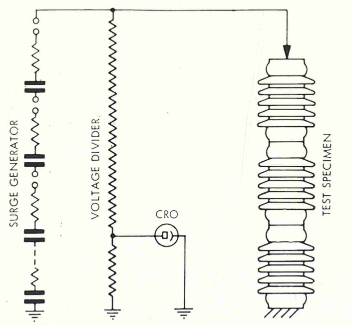



**Figure 4** — Full-wave withstand tests are made by impressing the entire 1.2 x 50 microsecond wave on the specimen.

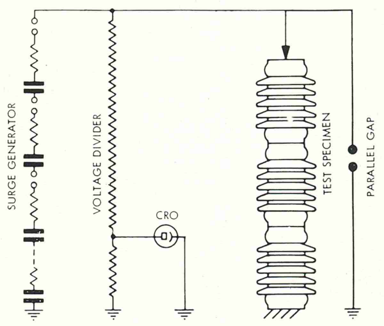



**Figure 5** — Chopped-wave and front-of-wave tests are made by using an adjustable gap in parallel with the specimen.

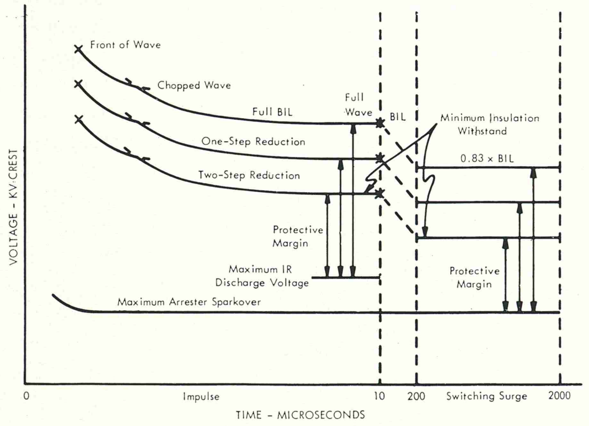
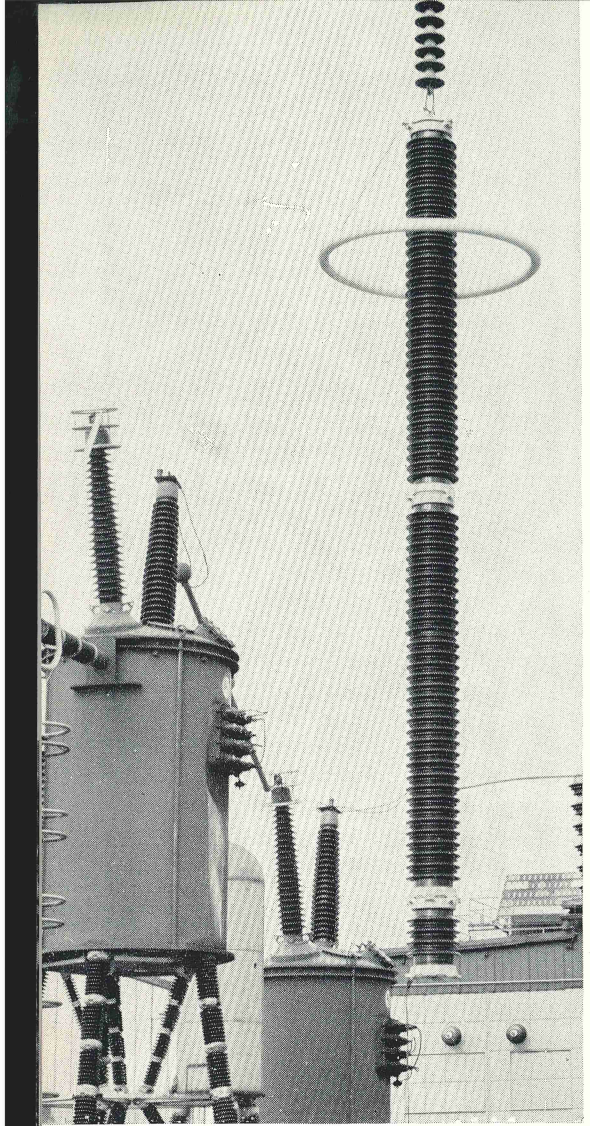


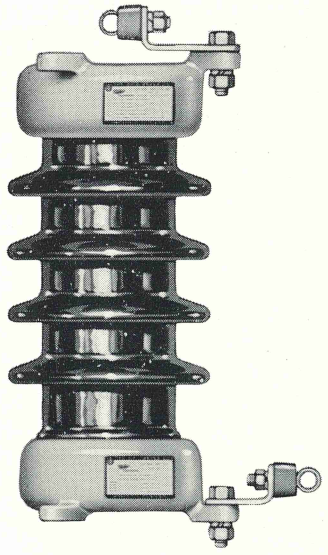

**Figure 6** — Typical insulation coordination diagram shows method by which reductions in insulation can be analyzed on the basis of maintaining ample protective margins.



# Current-limiting Dynagap stretches life expectancy of GP intermediate arresters

## Gap element relieves load on valve blocks by using arc voltage to force immediate interrupting action

**FIGURE 1** GP intermediate arresters (15-kv model shown below) have the same Dynagap interrupting element as O-B's most powerful station class MPR arresters.



Inherent characteristics of valve blocks used in Ohio Brass GP intermediate arresters have been reapportioned through changes in their composition to provide greatly increased durability to repeated discharges of heavy surge currents. This operating improvement is possible only because the current-limiting Dynagap transfers most of the responsibility for power-follow current limitation from the valve blocks to the series gap itself.

In intermediate - arrester design only Ohio Brass GP's have progressed beyond the conventional (magnetic or otherwise) series-gap construction used in conjunction with high-impedance valve blocks. GP intermediate arresters as shown in Figure 1 incorporate the same current-limiting Dynagap which is used to produce the industry's most advanced and capable station-class MPR arresters. The resulting benefits have been made available to utilities without increasing the arrester's cost over other intermediate models. Available GP arresters have ratings from 3 to 120 kv.

The true criterion for appraising arrester qualifications comes in analyzing the operations which culminate in the restoration of normal system operation. The simplest gap structure can be arranged to sense and discharge lightning surges. In such cases the valve blocks carry almost the entire load of furnishing the resistance necessary to reduce the flow of 60-cycle follow current to the level at which it can be interrupted when system voltage reaches its zero value. This dominating requirement has traditionally ruled valve-block composition in all conventional arresters, in spite of the recognized improvements which might otherwise have been incorporated.

The current-limiting Dynagap in GP intermediate arresters uses the arc voltage of its gap to limit the power-follow current. Its exceptionally compact structure, illustrated in Figure 2, consists of a stack of glass-bonded mica discs, each providing mounting for the consecutive gap electrodes, with the entire gap system series connected. Each set of electrodes operates in a gap chamber formed by the few thousandths of an inch spacing between adjacent discs. On either end of the gap structure is a powerful magnetic coil which is by-passed by the lightning surge, but rapidly activated by the 60-cycle current.

Initial sparking distance of the Dynagap is across a very short path. This path increases to 140 times its initial length as the arc is magnetically drawn out into the fan-shaped electrode runners. While the arc is thus being stretched, it is in contact with the confining faces of the gap chamber, which exert a rapid cooling effect. Stretching and cooling the arc demands ever-increasing voltage across the gap to compensate for the loss of thermal energy. This arc-voltage requirement quickly exceeds the available instantaneous 60-cycle line voltage, and arc extinction occurs entirely independently of when the normal system voltage reaches zero value.

All of these functions are confined to the spark-gap element and occur practically independently of the valve blocks. Analytical research conducted on the operation of the Dynagap-equipped intermediate arrester shows that the valve blocks contribute less than half of the resistance limiting the flow of power-follow current.

GP arrester performance has shown a substantial over-all improvement as a direct result of this comprehensive realignment of valve-block duty. Formulas and processes (Figure 3) involved in the production of blocks have been changed to alter the characteristics of the completed valve blocks. Principal difference in the new blocks is a significant decrease in impedance which results in much lower IR discharge voltages and an important increase in both durability and thermal capacity.

Field service records of GP Dynagap arresters substantiate an extended life expectancy in providing their protective function under the severe operating conditions frequently imposed on intermediate-arrester installations.

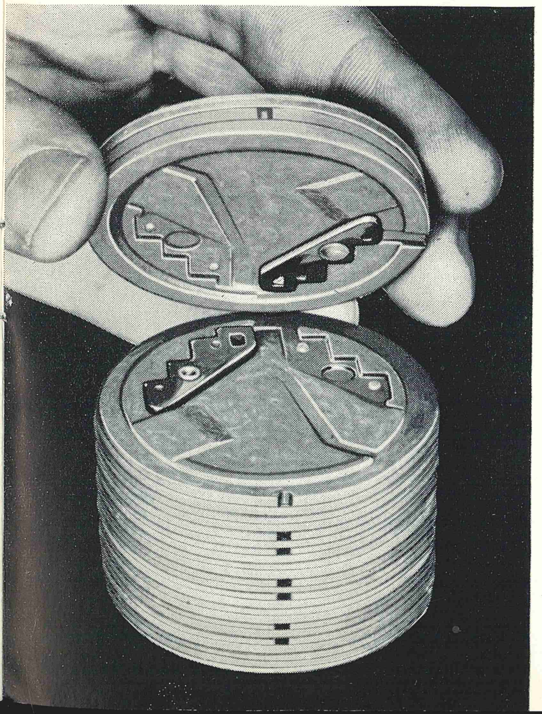


**FIGURE 2** The current-limiting Dynagap element consists of a compact stack of thin discs which position the gap electrodes and provide the arc-cooling cavities during interrupting cycle.

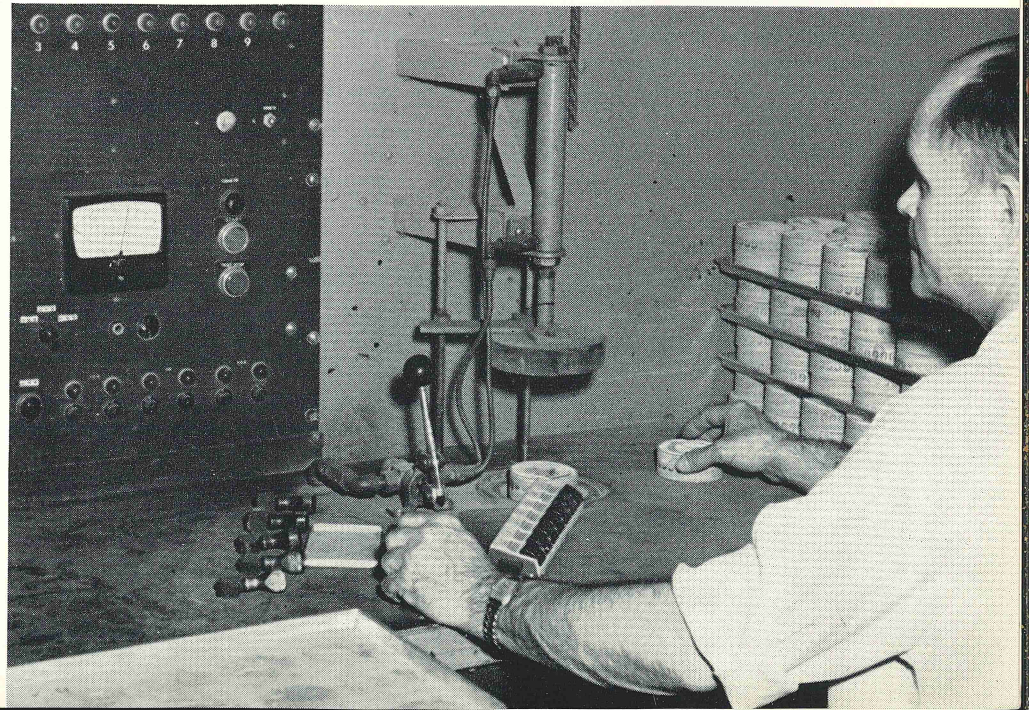


**FIGURE 3** Valve blocks for GP intermediate arresters are formed and fired from special compounds, then electronically tested and given pre-conditioning surges for the purpose of improving durabliity characteristics.

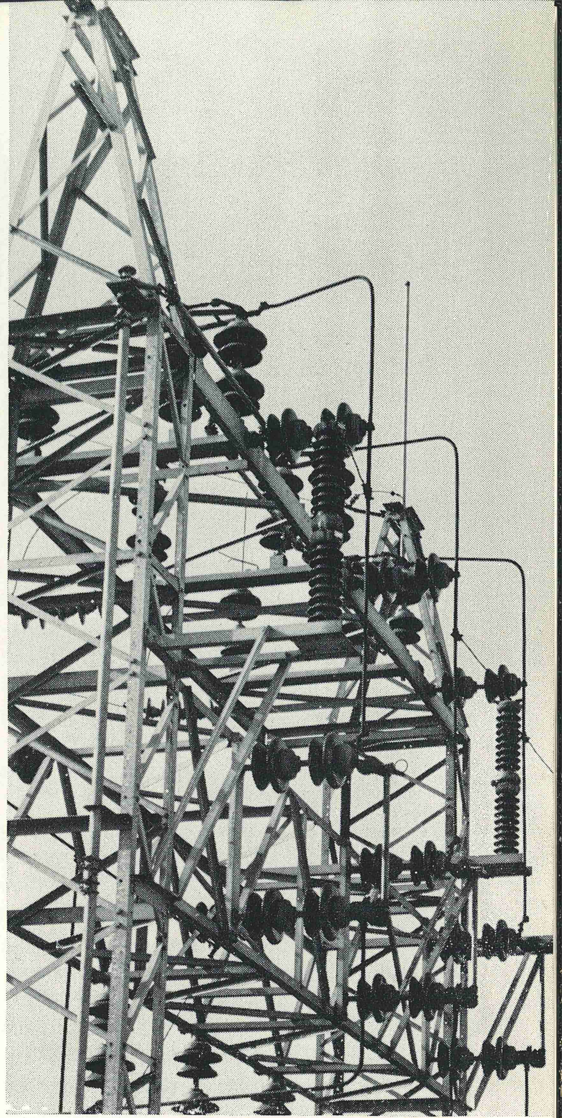


**FIGURE 4** Installation of GP intermediate arresters rated at 60 kv on typical 69-kv substation.

# Uprating of rotation system makes Holan Mustang 72 Derrick better . . . and better

Now, they've done it again. Boosted torque at the boom tower to a whopping 138,000-pound inches on the Holan Mustang 72 Derrick. Noting the need for increased power in derrick rotation systems, Holan engineers have completely redesigned the rotation mechanism of the Mustang 72.

Higher torque ratings, increased durability, and greater dependability mean further improvement in the smooth operation of this proved performer. System simplicity cuts down maintenance time and cost — minimizes time lost for service and repairs.

Design of the modified rotation system is basically the same as described in the September, 1965 issue of *HI-TENSION NEWS*. The system employs twin, single-acting pull cylinders, connected by a three-strand, high-strength roller chain to a constant radius sprocket to turn a vertical torque tube in a 365-degree range. The system is housed under the base-frame floor for a low center of gravity. But refinement of smoother, more dependable opera-pull cylinder mounting means tion, and redesign of certain components increases service convenience.

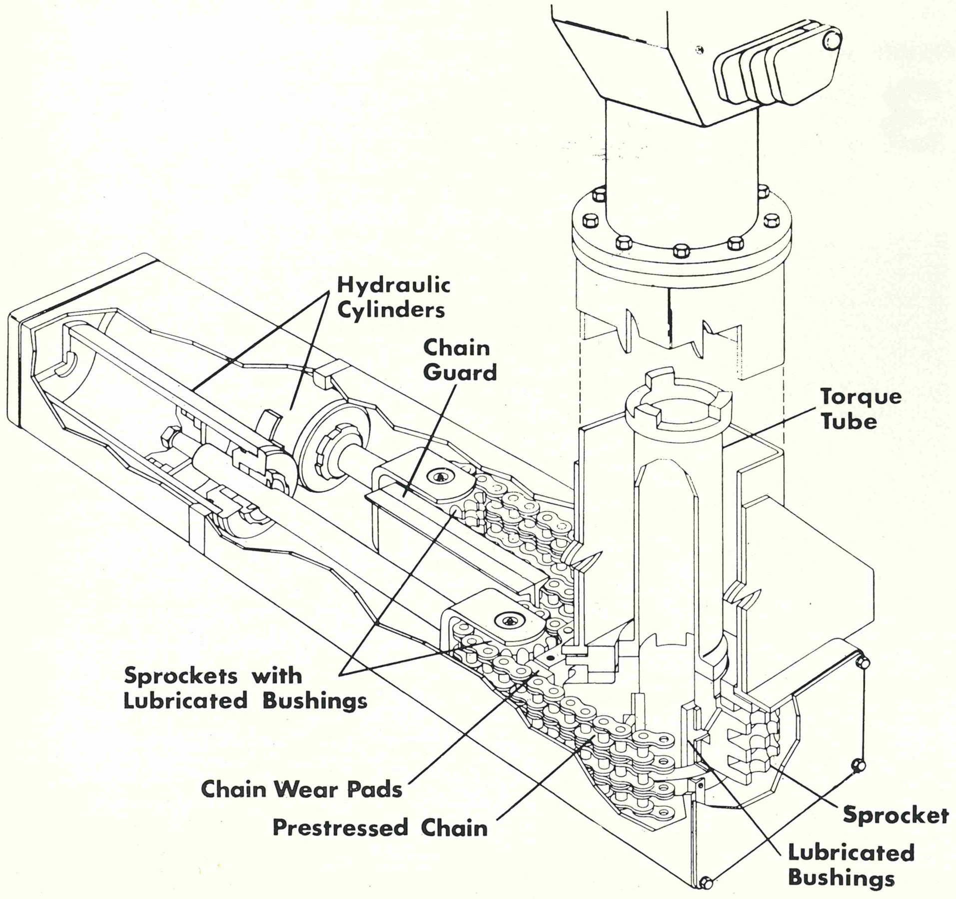
"Straight line" pull on the triple-roller rotation chain — with balanced loading on the three-chain strands and increased chain life — is a sure thing, with mating spherical sector surfaces on hydraulic-pull cylinder barrels and mounts. The arrangement "works like a ball joint," assuring smooth chain travel, without hang-ups. Long cylinder strokes compensate for chain wear over many years of service, so there's no need for wear take-up adjustment. And there's more power on the pull cylinders now — barrel diameter is increased to 5½ inches.

With its ruggedness and reliability, the Mustang 72 rotation system offers almost instant access for service. The chain anchor block, for example, is now an independent component, with knock-out anchor pins for easy removal. Master links in the roller chain facilitate disassembly when necessary. And secondary sprockets are bearing mounted for smooth operation, with provision for lubrication and service access.

Even the "bull sprocket" is easy to remove in the new mechanism. The sprocket support, at the bottom of the rotation gear housing, is simply dropped away for easy sprocket removal.

A special motion-control and lock-valve system, installed in the pull cylinder supply lines, prevents reverse flow of fluid when side loads are imposed on the derrick boom.

More data on this dependable, fail-safe rotation system and the rugged Mustang 72 can be obtained from Holan Division, The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.




Larger-diameter pull cylinders increase boom tower torque in modified Mustang 72 rotation system. "Ball joint" floating cylinder mounts insure proper alignment and long life for the triple-roller pull chain — preventing hang-ups, power losses, and uneven loading of individual chain strands.

# Third hand . . . courtesy of O-B

## Spring actuated jaw of Universal Strain Clamp is like an extra hand for the lineman

A lineman does three things at once while installing a deadend clamp: He holds the clamp. He forms-in the cable. He tightens the clamping nuts. It would be easy, if he had three hands!

With the Universal Strain Clamp, that third hand is built-in. A spring and fulcrum arrangement applies positive force to hold the jaw open. No part is disassembled. Clamping nuts are simply backed away until the jaw opening is sufficiently wide. There is still plenty of thread left to keep the nuts from dropping off. When the cable is in place the nuts are easily spun down. Two ordinary hands will do the job . . . the third is supplied by courtesy of O-B.

Considerable time is saved, and time these days is worth more than a slight difference in price between clamps.

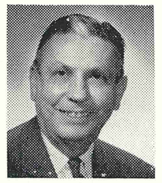
Firm grip on the cable is enhanced by almost a full circle of snubbing action. Universal Clamps will develop the rated strength of most cables, if ever called upon to do so.

For a deadending job that starts with a saving and ends with security, specify the Universal Strain Clamp.

Distributed by Graybar Electric Company

# Words on a "sorry" attitude and how to stamp it out, maybe

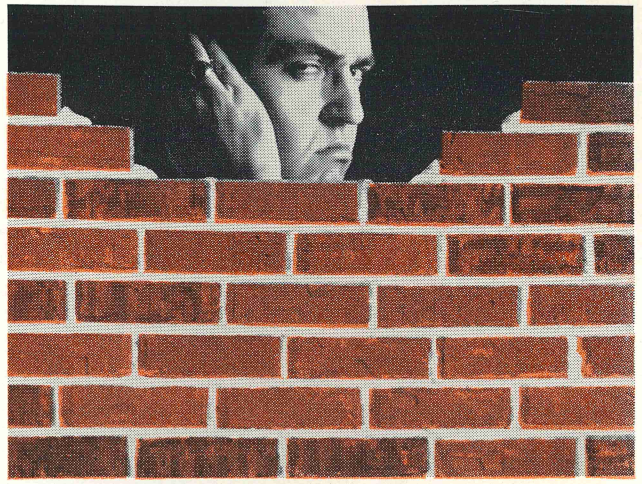
**BY ROGER A. BLACK**
PRESIDENT, OHIO BRASS COMPANY



"I'm sorry, but that's not my department." The words may be different, but the attitude that goes with them is always the same. If management could stamp out this attitude, think of the wonders that would be accomplished. Financial men might become more tolerant of production and engineering people and more understanding of the salesman. The engineer would explore the wonders of the market place. In an industry beset by shortages of materials and tempers, buyer and seller could switch positions and discover that the other fellow is still trying to do the best job he can.

**AT OHIO BRASS** our products and associations with the utility industry have expanded to the point that the company and individuals in the company can't afford "not my department" thinking.

**CONSIDER A FEW** of the improbable things that aren't exactly "in our department." Sixteen years ago we had to delve deeply into the theory and construction of transformers when we introduced a lightning arrester for the protection of such equipment. And since arresters dealt with lightning, some men even sought a greater knowledge of meteorology. We developed an active interest in real estate values when we began promoting V-string construction for the conservation of right-of-way. We became highly conscious of public relations when we started working on radio-silent insulation.



**IT WOULD TAKE** comparatively simple, inexpensive equipment to prove that an insulator meets published catalog values. But we have assigned acres of valuable land to laboratories and spent millions of dollars on elaborate testing equipment to put those insulators on full-size towers, supporting their proposed conductor system, in a realistic outdoor environment where test answers are most dependable . . . but towers and conductors are not "in our department."

**PERHAPS THE SOLUTION** lies in a proper answer to: "What is our department?" As long as an O-B product is involved, THAT IS our department. 748-H

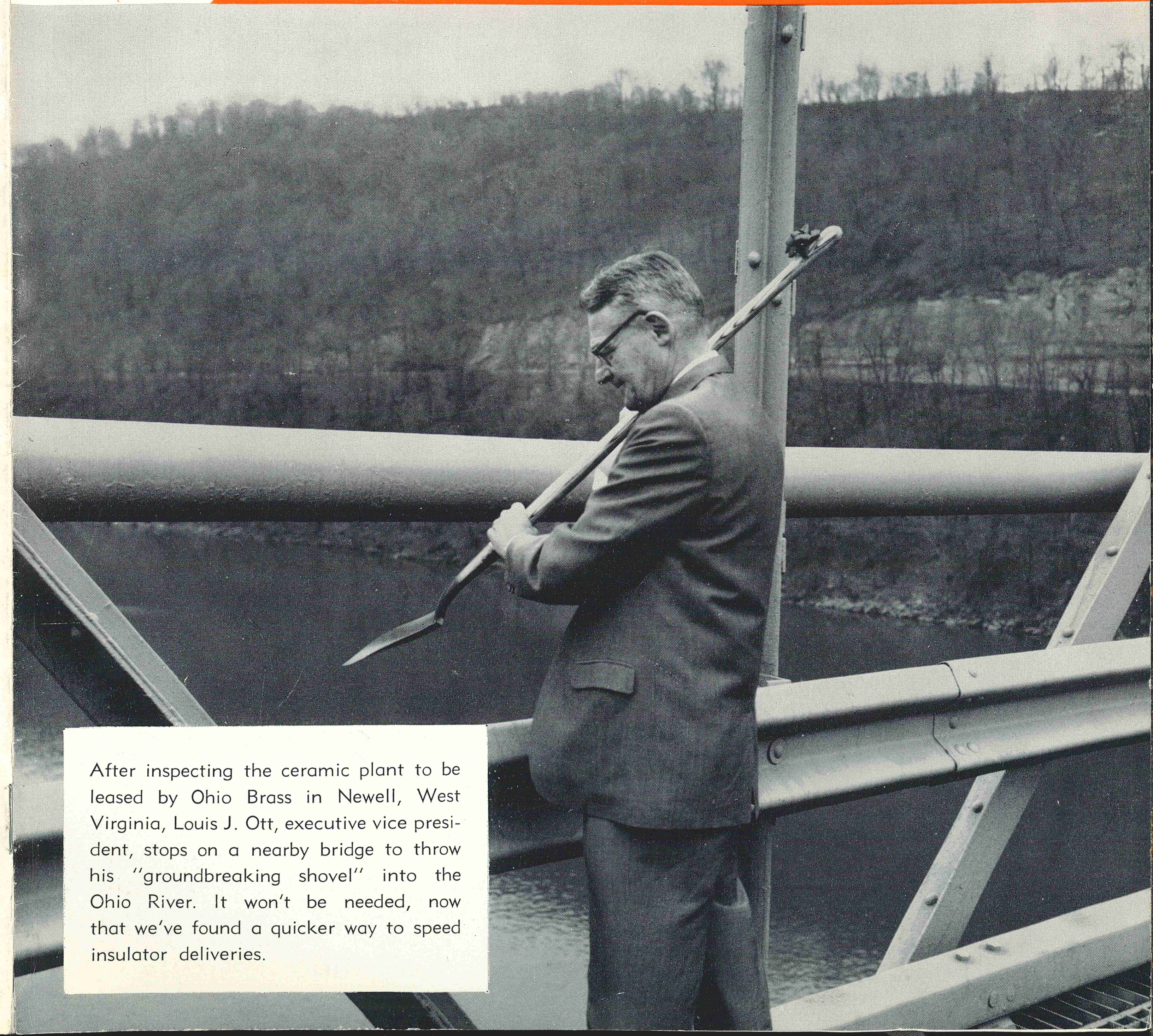
OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS



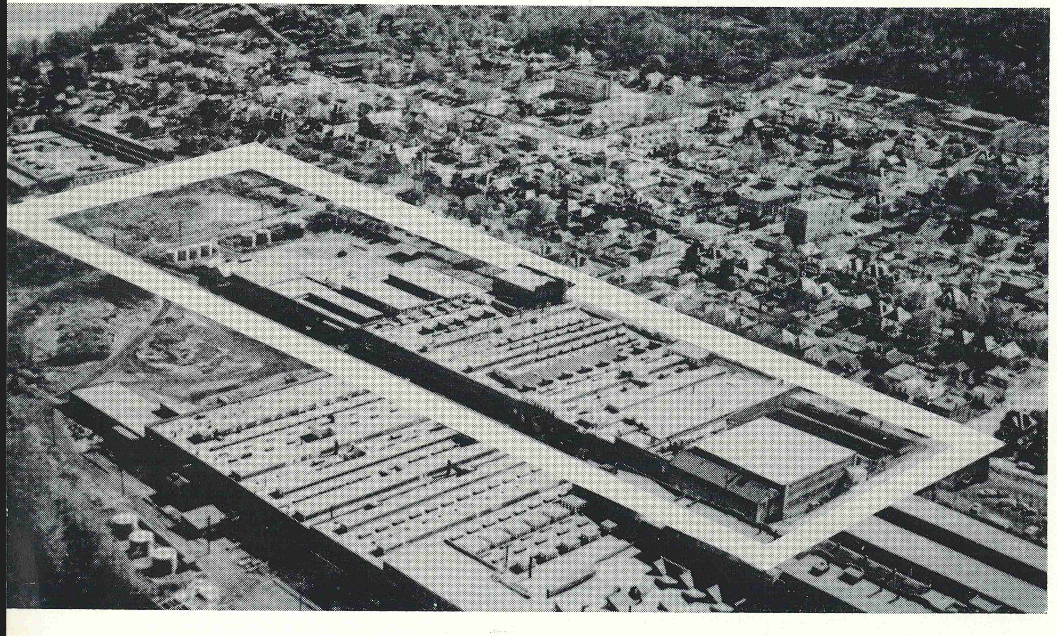


Hi-Tension News
JUNE 1966



After inspecting the ceramic plant to be leased by Ohio Brass in Newell, West Virginia, Louis J. Ott, executive vice president, stops on a nearby bridge to throw his "groundbreaking shovel" into the Ohio River. It won't be needed, now that we've found a quicker way to speed insulator deliveries.

# O-B LEASES LARGE FACILITY FOR EXPANDED INSULATOR PRODUCTION



Aerial view of the 356,000-square-foot plant which will be converted as rapidly as possible into expanded manufacture of O-B insulators. Well over a year of construction and organization have been by-passed with the acquisition of this large ceramic plant.

Down from a bridge went a brand new shovel into the Ohio River. Our executive vice president, Louis J. Ott, had been presented with this shiny ceremonial shovel by one of our good customers to use in a groundbreaking celebration. We had been ready to build a new factory to increase O-B insulator production. But the shovel wasn't needed. In lieu of a new building that would take well over a year to erect, we now have 356,000 square feet (eight acres) of immediately available space for expanded insulator manufacture. After inspecting these facilities and appraising their immediate potential, our vice president disposed of his groundbreaking shovel with no regrets!

O-B has leased the entire plant of what was formerly the Edward M. Knowles China Company of Newell, West Virginia. This plant was originally built for ceramic manufacture and admirably fits our requirements for insulators. Probably its greatest asset, under present circumstances, are two large continuous kilns in excellent working condition. Having them available will cut as much as a year from the time needed to get the plant into operation, and will add over 33 per cent to O-B's total kiln capacity. These kilns will facilitate porcelain production as quickly as machinery can be obtained and set up.

First step in the utilization of this plant, and one which can be put into effect almost at once, is insulator assembly.



Even more important — immediate steps will be taken to install complete and greatly enlarged post production facilities.

O-B has been investigating every possible means of increasing insulator volume, with the element of time the foremost consideration. It has appeared infinitely preferable to move into an existing building, ready to accommodate production, rather than to start with a mere hole in the ground.

Another very important factor relates to the location of this plant. Newell and Chester, West Virginia, are across the Ohio River from East Liverpool, Ohio. Centering in this area and extending south down the river, is the heart of the Nation's ceramic industry. Competition has forced many companies out of business. Therefore, skilled ceramic workers are available who can give us increased production with a minimum training period.

First official greeting to plant visitors is performed by the newly appointed manager, Arnold F. Kozlowski (left), at the office reception desk. His guests are Louis J. Ott, executive vice president, and Estes C. Thompson, vice president, manufacturing, of Ohio Brass.

Newell's location of only 75 miles from Barberton and 125 miles from Mansfield, means overnight shipment between plants and convenient access for technical and production personnel.

Speaking frankly to the buyers and users of O-B insulators, no matter how happy they may be in seeing some tangible relief for present extended delivery problems, we are equally gratified. The hardest thing a supplier must do is say "no" to an order. While our customers have been remarkably tolerant and understanding, there is little satisfaction in seeing a "tolerant and understanding customer" buy his materials from someone else . . . especially outside the United States. We sincerely believe this large expansion of O-B production will have a noticeable and early effect on insulator supply.

Almost priceless assets in the plant, originally occupied by the Edward M. Knowles China Company, are two large continuous kilns in fine operating condition. This will permit early production, contrasted to perhaps a year's delay, and adds over 33 per cent to O-B's total kiln capacity.

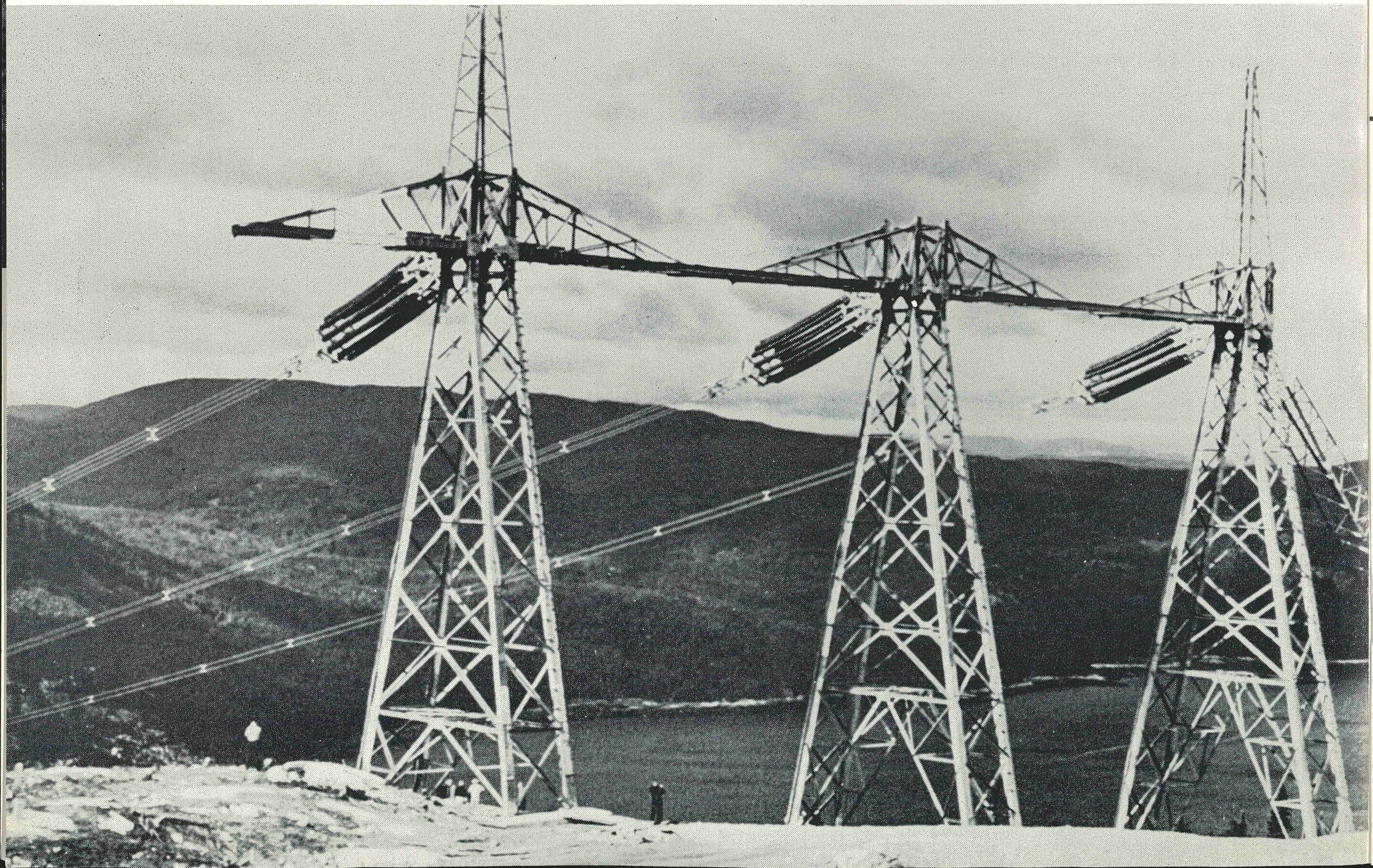
# Specification of EHV deadend equipment simplified by full assembly catalog numbers

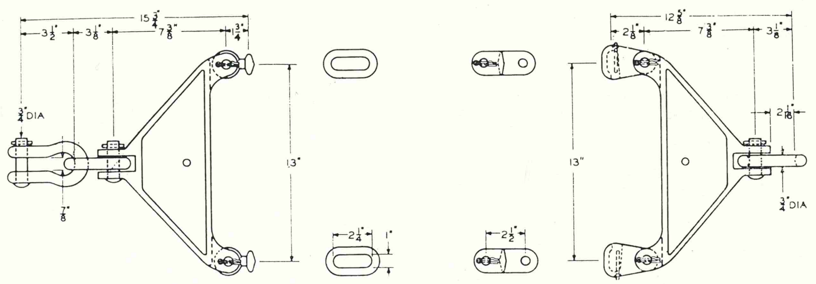
As a major supplier of construction materials, we see increasing evidence that EHV projects involve a higher proportion of heavy deadends than existed in the day of more conventional voltages. The tendency to build generating plants adjacent to supplies of fuel and water often calls for long distance transmission, frequently over rough terrain. Large valleys or waterways are a normal expectation in the size and nature of territory involved. Therefore we commonly encounter long crossings.

Tensions on these long spans are magnified by the diameter and number of sub-conductors per phase. This not only increases static weight but also has a profound effect on ice and wind loadings. Therefore, where a deadend is needed, it is often a heavy piece of construction. Possibly the greatest mechanical load so-encountered is the 6,900-foot crossing of the Saguenay River on the 735-kv Hydro-Quebec project. Here, each phase consists of four 1.1-inch steel cables. Ultimate strength of deadends is 600,000-pounds per phase. Expected load on each phase is 260,000 pounds with ice and wind. And on the Saguenay, ice and wind easily justify the term "expected."

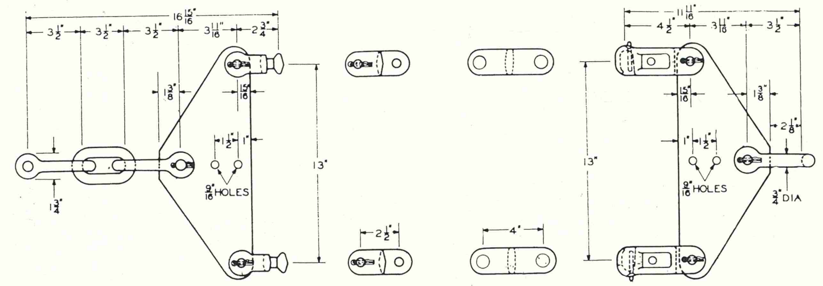
Designers of EHV lines may be aided by a review of O-B deadend assemblies. These are illustrated and rated for strength. Such assemblies are supplied complete under a single catalog number, with all parts and fittings included. Special combinations for unusual duty often involve certain exceptions or custom design, and naturally do not lend to being cataloged. Insulators are not shown because of their range in choice of strength. Many engineers prefer to use insulating members with a considerable surplus of rating to keep safety factors high in their deadend construction. Therefore, insulator specification is left to the user.

Ultimate strength of each phase in this massive deadend is 600,000 pounds, making a total of 1,800,000 pounds for the structure. Four 1.1-inch steel cables per phase cross the Saguenay River with a span of 6,900 feet on this 735-kv project.

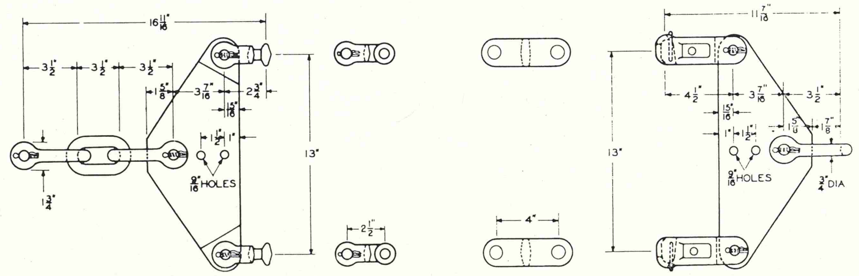




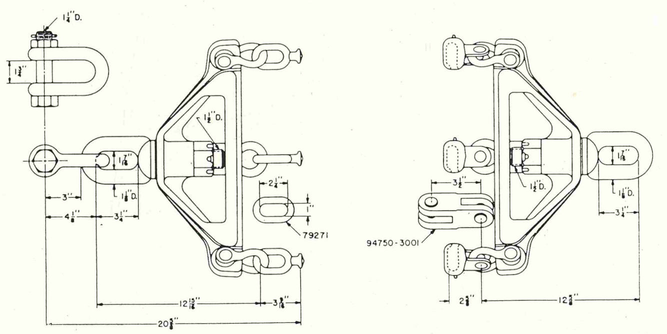
For light duty, this two-string assembly with malleable iron yoke plates has an ultimate strength rating of 25,000 pounds. Equipped for ball-socket insulators it carries a Catalog Number of 79680. For clevis-type insulators use Number 79681. Alternate fittings for the two types of insulators are illustrated.



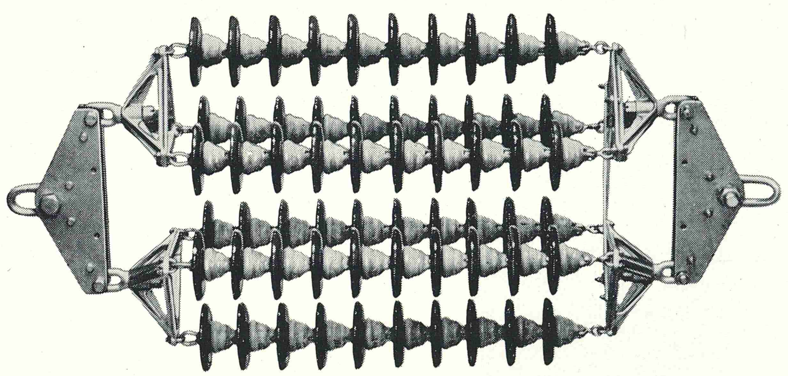
Medium duty construction utilizes a steel yoke plate that increases the ultimate strength rating of this two-string assembly to 36,000 pounds utimate. For ball-socket insulators specify Catalog Number 79631. If clevis-type insulators are used, the Number is 79632. All parts of all assemblies shown are heavily protected with galvanizing.



For two insulator strings in heavy duty service, this steel yoke plate assembly has an ultimate strength of 60,000 pounds. For ball-socket insulators, the Catalog Number is 79633. For clevis type the Number is 79634. With any of the preceding assemblies, two or three can be combined for higher ratings.



Three strings of insulators are used with this extra-heavy assembly rated at 90,000 pounds ultimate. The ball-socket version carries Catalog Number 79697. Clevis type is Number 79698. A practice gaining in popularity, where strains are high, is to deadend each sub-conductor independently rather than deal with strain on the total bundle. A similar assembly is available in a 110,000-pound ultimate strength rating, with insulator strings on 18-inch centers.



This six-string assembly is typical of many multiple deadend arrangements. A triangular master yoke would permit use of nine strings if desired. In such cases, ultimate strengths would be 180,000 or 270,000 pounds, respectively. Master yokes are supplied on special order, as they frequently involve custom design.

# O-B's High Voltage Laboratory:

# Aims for specific targets in programming high-voltage impulse tests

## Expert manipulation of huge surge generator produces front-of-wave, chopped-wave, and full-wave withstand values

Determination of insulation withstand voltages for various electrical components such as suspension insulators, posts, pincaps, bushings, and similar equipment requires separate and different testing procedures to investigate the impulse and continuous (or 60-cycle) insulation strengths. The O-B High Voltage Laboratory has the complex, specialized surge generators which enable its staff of research engineers to conduct the high-voltage trials required for complete evaluation.

Impulse testing establishes the ability of a specimen to survive anticipated overvoltage surges. These surges can appear on the line as a result of lightning, switching operations, or other transient disturbances. They are characterized by their comparatively short duration and by voltage levels far above normal operating conditions.

The wave form of overvoltage surges becomes an important factor in the investigation of insulation withstand strengths. The wave front defines the rate of increase of voltage in respect to time, while the wave tail indicates the duration of the surge. Statements of impulse withstand strength must, therefore, define both the wave shape and voltage of the applied test surge.

Overvoltage surges may occur in an infinite variety of wave forms, ranging from extremely steep front lightning surges of very short duration to the switching surges with their typical slow-rising fronts and substantially longer durations. Under such conditions industry has elected to use the easily reproducible 1.2 x 50 microsecond wave as its standard for impulse withstand-test procedures. The 1.2 x 50 microsecond wave (Figure 1) is defined as having a crest voltage which is reached in 1.2 seconds and a wave tail which decays to ½ crest value in 50 microseconds.

Impulse test procedures use the 1.2 x 50 mu-sec voltage wave to determine a series of characteristics relating to the specimen which can then be consolidated to establish the impulse insulation withstand strength. The test series consists of three groups of trials by which values are obtained for full-wave withstand, chopped-wave withstand and usually for front-of-wave withstand. Each of these tests is accomplished by variations in the procedure by which the impulse generator applies the high-voltage surges to the specimen. Figure 2 illustrates a typical impulse flashover on stacking posts supporting an air break switch. Many consecutive trials must be made in order to establish the final test values. Results are normally displayed in the form of a curve (Figure 3) which delineates the front-of-wave, chopped-wave and full-wave withstand voltages as a function of time.

Sequence of testing normally consists of completing the full-wave withstand trials before initiating the chopped- and front-of-wave tests.

The full-wave withstand voltage test applies the 1.2 x 50 mu-sec voltage wave in its entirety to the specimen. The value reported is the maximum voltage which causes no flashover. Figure 4 illustrates a simplified diagram of the impulse generator circuit as connected for making full-wave voltage tests. Full-wave withstand strength of equipment is commonly referred to as the basic impulse insulation level (BIL), a widely used term which defines the crest value of the impulse voltage which electrical equipment is required to withstand without failure or disruptive discharge.

In the chopped-wave test, an external air spark gap is added to the generator test circuit and connected in parallel with the specimen as shown in Figure 5. This gap is adjusted before tests are made so that the impulse voltage will flash over to ground at a definite time interval measured from the beginning of the test wave. The crest voltage of the chopped-wave impulse test is substantially higher than that established by full-wave testing, since the insulation of the specimen has a greater withstand strength in respect to the shorter duration of the impulse wave.

Front-of-wave testing is similar to that of the chopped-wave-test procedure, since the same circuit diagram of the impulse generator is applicable. In front-of-wave testing, however, the impulse wave is chopped by action of the parallel gap while the voltage is still rising to its crest value. Since the duration of the application of the impulse surge to the specimen has again been significantly reduced, the value of the voltage reported for front-of-wave withstand will be higher than either that of the full-wave or chopped-wave tests.

Proper application of BIL values in studies of system insulation coordination constitutes a systematic method by which improved system reliability can be obtained at substantially reduced insulation levels. The basic coordination diagram (Figure 6) illustrates the relation of the lightning arrester's impulse protective level to the equipment insulation withstand voltages. Recommended practice is to select first an arrester rating which is known to be capable of interrupting power-follow current under anticipated dynamic system overvoltages. Application of the appropriate protective margin then determines the lowest suitable BIL for station equipment. The opportunities for one-, two-, or even three-step reductions in the equipment BIL have saved millions of dollars in the cost of insulation of major electrical apparatus.

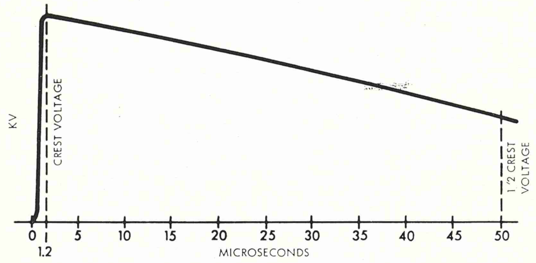



**Figure 1** — Standard impulse test wave (1.2 x 50 mu-sec) rises to crest voltage in 1.2 microseconds and decays to ½ crest voltage in 50 microseconds.

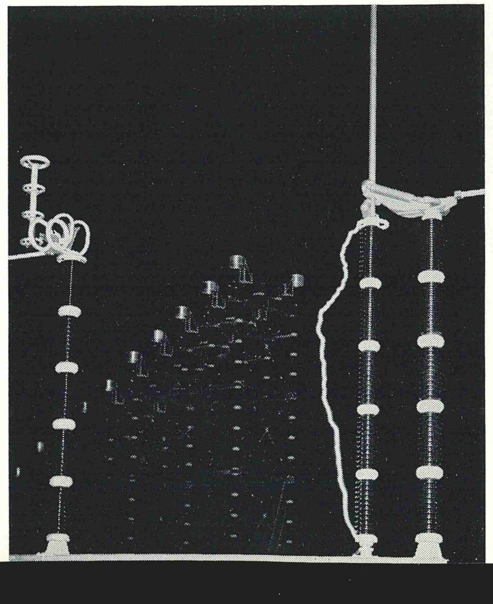


**Figure 2** — Impulse testing of air break switch insulation produces exterior flashover.

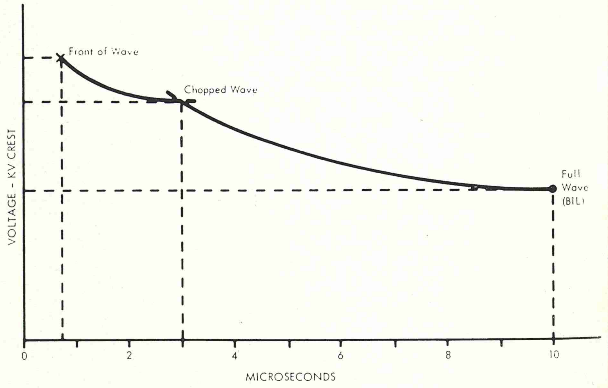



**Figure 3** — Impulse insulation withstand curve showing front-of-wave, chopped-wave and full-wave test values.

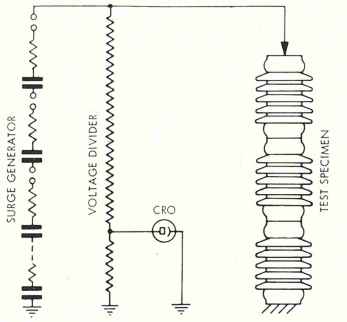



**Figure 4** — Full-wave withstand tests are made by impressing the entire 1.2 x 50 microsecond wave on the specimen.

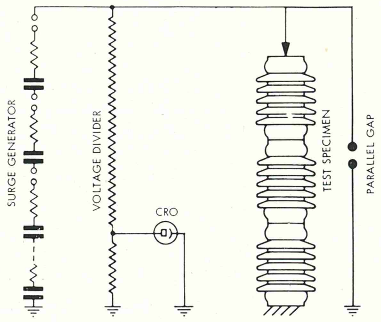



**Figure 5** — Chopped-wave and front-of-wave tests are made by using an adjustable gap in parallel with the specimen.

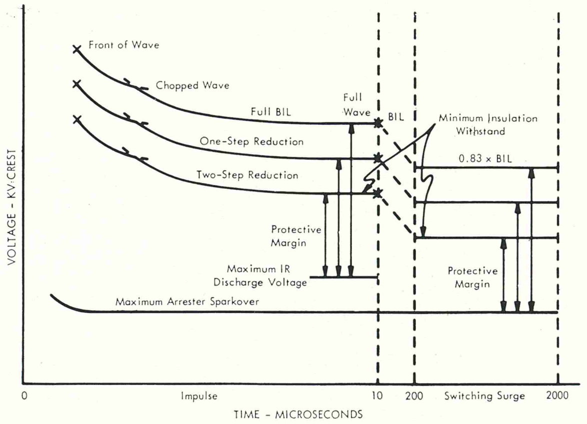
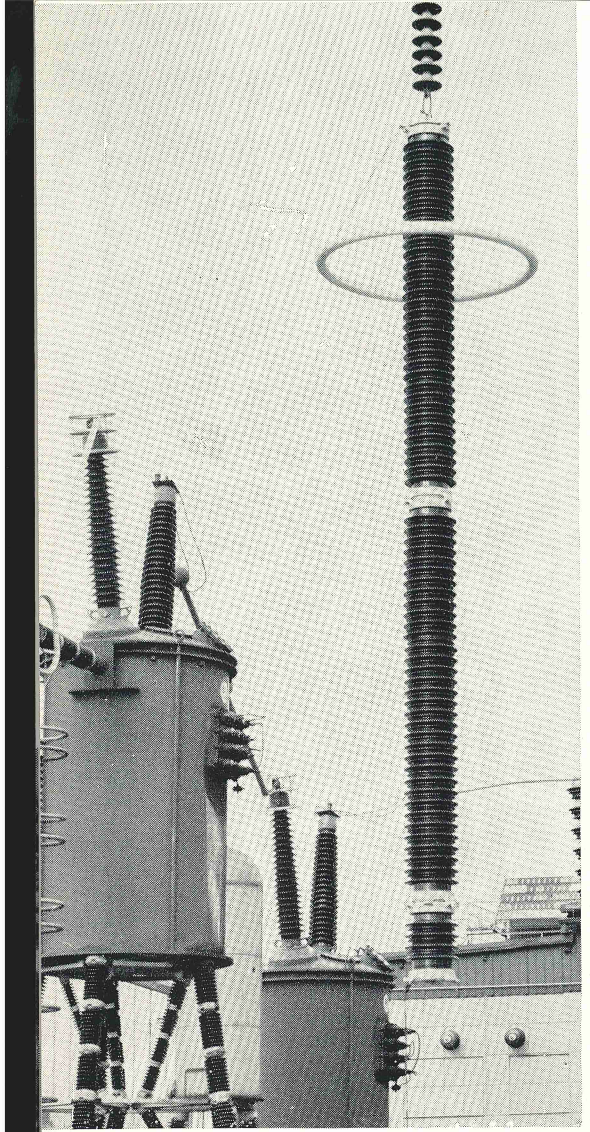


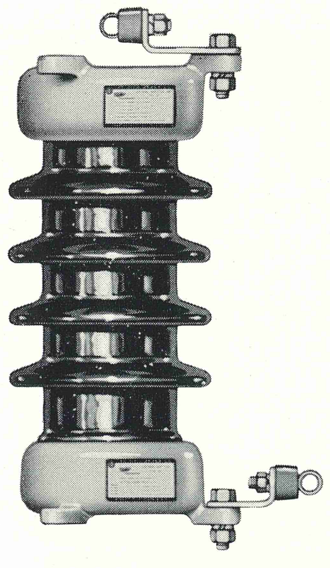

**Figure 6** — Typical insulation coordination diagram shows method by which reductions in insulation can be analyzed on the basis of maintaining ample protective margins.



# Current-limiting Dynagap stretches life expectancy of GP intermediate arresters

## Gap element relieves load on valve blocks by using arc voltage to force immediate interrupting action

**FIGURE 1** GP intermediate arresters (15-kv model shown below) have the same Dynagap interrupting element as O-B's most powerful station class MPR arresters.



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The true criterion for appraising arrester qualifications comes in analyzing the operations which culminate in the restoration of normal system operation. The simplest gap structure can be arranged to sense and discharge lightning surges. In such cases the valve blocks carry almost the entire load of furnishing the resistance necessary to reduce the flow of 60-cycle follow current to the level at which it can be interrupted when system voltage reaches its zero value. This dominating requirement has traditionally ruled valve-block composition in all conventional arresters, in spite of the recognized improvements which might otherwise have been incorporated.

The current-limiting Dynagap in GP intermediate arresters uses the arc voltage of its gap to limit the power-follow current. Its exceptionally compact structure, illustrated in Figure 2, consists of a stack of glass-bonded mica discs, each providing mounting for the consecutive gap electrodes, with the entire gap system series connected. Each set of electrodes operates in a gap chamber formed by the few thousandths of an inch spacing between adjacent discs. On either end of the gap structure is a powerful magnetic coil which is by-passed by the lightning surge, but rapidly activated by the 60-cycle current.

Initial sparking distance of the Dynagap is across a very short path. This path increases to 140 times its initial length as the arc is magnetically drawn out into the fan-shaped electrode runners. While the arc is thus being stretched, it is in contact with the confining faces of the gap chamber, which exert a rapid cooling effect. Stretching and cooling the arc demands ever-increasing voltage across the gap to compensate for the loss of thermal energy. This arc-voltage requirement quickly exceeds the available instantaneous 60-cycle line voltage, and arc extinction occurs entirely independently of when the normal system voltage reaches zero value.

All of these functions are confined to the spark-gap element and occur practically independently of the valve blocks. Analytical research conducted on the operation of the Dynagap-equipped intermediate arrester shows that the valve blocks contribute less than half of the resistance limiting the flow of power-follow current.

GP arrester performance has shown a substantial over-all improvement as a direct result of this comprehensive realignment of valve-block duty. Formulas and processes (Figure 3) involved in the production of blocks have been changed to alter the characteristics of the completed valve blocks. Principal difference in the new blocks is a significant decrease in impedance which results in much lower IR discharge voltages and an important increase in both durability and thermal capacity.

Field service records of GP Dynagap arresters substantiate an extended life expectancy in providing their protective function under the severe operating conditions frequently imposed on intermediate-arrester installations.

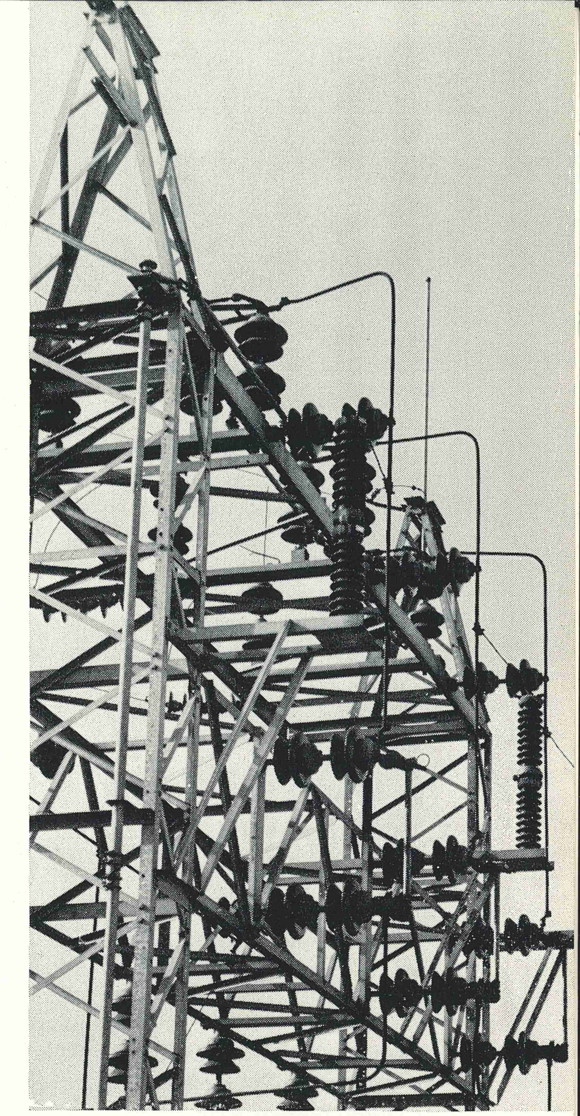


**FIGURE 2** The current-limiting Dynagap element consists of a compact stack of thin discs which position the gap electrodes and provide the arc-cooling cavities during interrupting cycle.

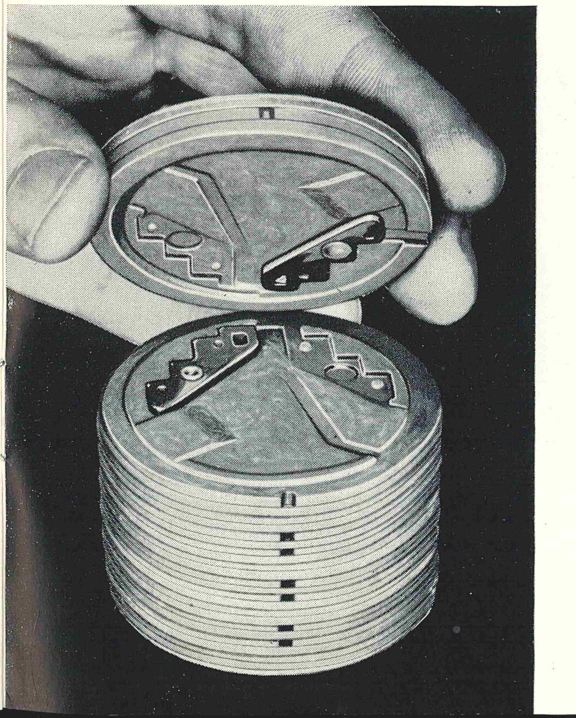


**FIGURE 3** Valve blocks for GP intermediate arresters are formed and fired from special compounds, then electronically tested and given pre-conditioning surges for the purpose of improving durabliity characteristics.

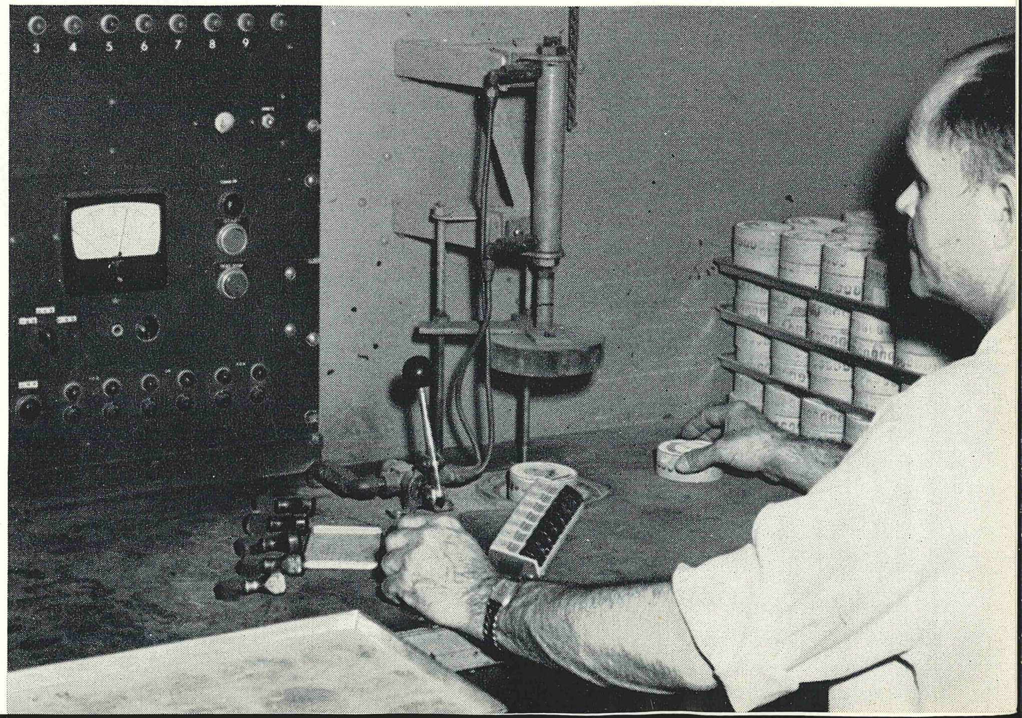


**FIGURE 4** Installation of GP intermediate arresters rated at 60 kv on typical 69-kv substation.

# Uprating of rotation system makes Holan Mustang 72 Derrick better . . . and better

Now, they've done it again. Boosted torque at the boom tower to a whopping 138,000-pound inches on the Holan Mustang 72 Derrick. Noting the need for increased power in derrick rotation systems, Holan engineers have completely redesigned the rotation mechanism of the Mustang 72.

Higher torque ratings, increased durability, and greater dependability mean further improvement in the smooth operation of this proved performer. System simplicity cuts down maintenance time and cost — minimizes time lost for service and repairs.

Design of the modified rotation system is basically the same as described in the September, 1965 issue of *HI-TENSION NEWS*. The system employs twin, single-acting pull cylinders, connected by a three-strand, high-strength roller chain to a constant radius sprocket to turn a vertical torque tube in a 365-degree range. The system is housed under the base-frame floor for a low center of gravity. But refinement of smoother, more dependable opera-pull cylinder mounting means tion, and redesign of certain components increases service convenience.

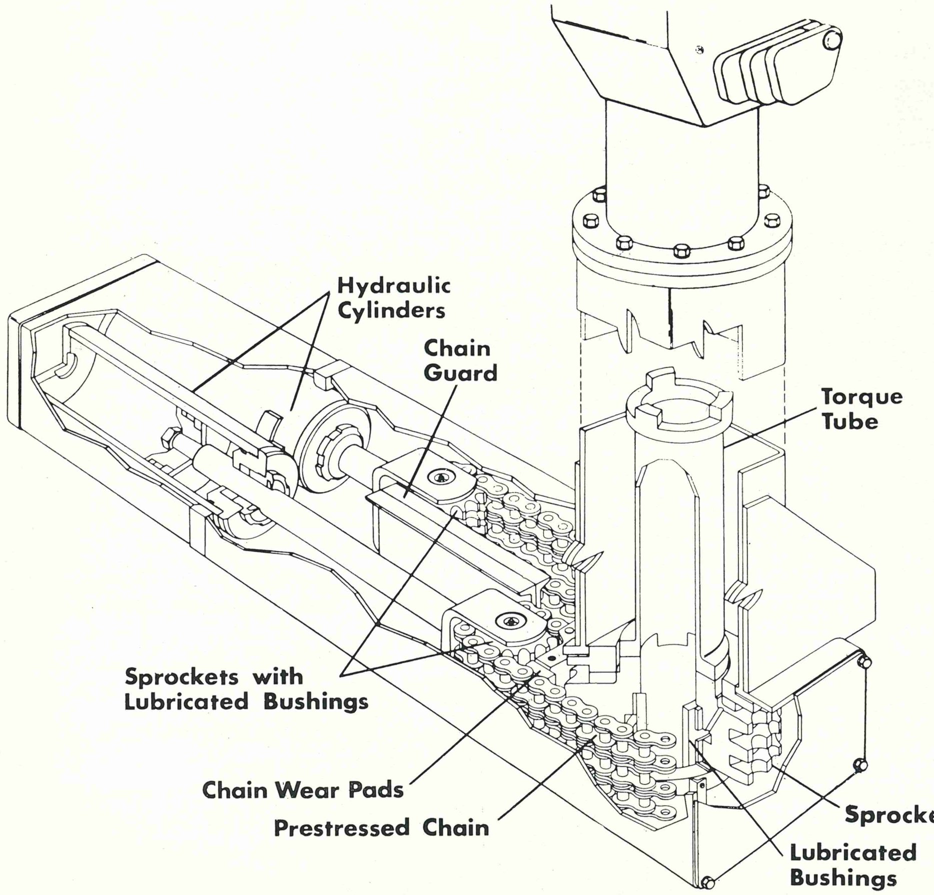
"Straight line" pull on the triple-roller rotation chain — with balanced loading on the three-chain strands and increased chain life — is a sure thing, with mating spherical sector surfaces on hydraulic-pull cylinder barrels and mounts. The arrangement "works like a ball joint," assuring smooth chain travel, without hang-ups. Long cylinder strokes compensate for chain wear over many years of service, so there's no need for wear take-up adjustment. And there's more power on the pull cylinders now — barrel diameter is increased to 5½ inches.

With its ruggedness and reliability, the Mustang 72 rotation system offers almost instant access for service. The chain anchor block, for example, is now an independent component, with knock-out anchor pins for easy removal. Master links in the roller chain facilitate disassembly when necessary. And secondary sprockets are bearing mounted for smooth operation, with provision for lubrication and service access.

Even the "bull sprocket" is easy to remove in the new mechanism. The sprocket support, at the bottom of the rotation gear housing, is simply dropped away for easy sprocket removal.

A special motion-control and lock-valve system, installed in the pull cylinder supply lines, prevents reverse flow of fluid when side loads are imposed on the derrick boom.

More data on this dependable, fail-safe rotation system and the rugged Mustang 72 can be obtained from Holan Division, The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.




Larger-diameter pull cylinders increase boom tower torque in modified Mustang 72 rotation system. "Ball joint" floating cylinder mounts insure proper alignment and long life for the triple-roller pull chain — preventing hang-ups, power losses, and uneven loading of individual chain strands.

## Third hand . . . courtesy of O-B

### Spring actuated jaw of Universal Strain Clamp is like an extra hand for the lineman

A lineman does three things at once while installing a deadend clamp: He holds the clamp. He forms-in the cable. He tightens the clamping nuts. It would be easy, if he had three hands!

With the Universal Strain Clamp, that third hand is built-in. A spring and fulcrum arrangement applies positive force to hold the jaw open. No part is disassembled. Clamping nuts are simply backed away until the jaw opening is sufficiently wide. There is still plenty of thread left to keep the nuts from dropping off. When the cable is in place the nuts are easily spun down. Two ordinary hands will do the job . . . the third is supplied by courtesy of O-B.

Considerable time is saved, and time these days is worth more than a slight difference in price between clamps.

Firm grip on the cable is enhanced by almost a full circle of snubbing action. Universal Clamps will develop the rated strength of most cables, if ever called upon to do so.

For a deadending job that starts with a saving and ends with security, specify the Universal Strain Clamp.

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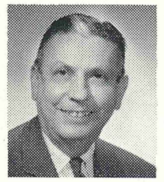
OHIO BRASS MANAGEMENT REPORT

# Industry can solve the case of the "obsolete senior"

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY



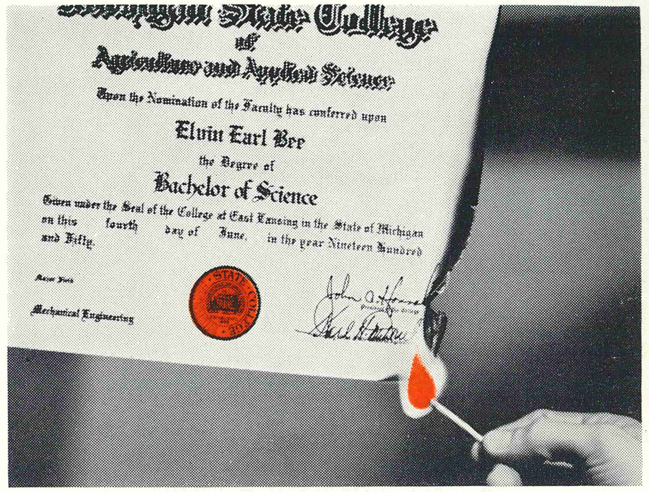
It might happen at some graduation ceremony in June. The engineering school senior accepts his diploma, walks off the platform, and turns perplexed to his parents: "What am I going to do? My education is obsolete." Farfetched? Not if you believe the comment by a junior engineering student recently reported in a Cleveland newspaper. "Things I learned in my sophomore year are already obsolete," he said.

**ACCORDING TO AUTHORITIES** quoted in the same article, the problem has developed because there is more than ever to learn. The world's store of knowledge doubled between 1750 and 1900, doubled again from 1900 to 1950, again between 1950 and 1960, and will double a fourth time by 1968. "It's a race between graduation and obsolescence," according to one educator. All this poses a serious dilemma. Theoretically, at least, people who want to keep their education up to date would have to spend their entire life in school and never have the opportunity for practical application of their knowledge.

**I THINK THE ANSWER LIES,** as always, in developing quality people who have the creative approach to practical problems. Regardless of education, one man can be obsolete at 22 while another is still going strong at 80.

**WHEN WE LOOK AT EXAMPLES** in our company of creativity at work, we see that it is not the exclusive province of the young or the highly educated, at least highly educated in the academic sense.

**TWO YEARS AGO** we put an automated molding machine in our malleable iron foundry. Despite the soundness of its design, it didn't produce up to our expectations until our engineers studied it and




made half a dozen significant refinements. Our men were electrical, not mechanical, engineers as were the men who designed the machine. But they studied the environment in which the machine had to operate. And their simple, but highly creative, suggestions followed. Their creativity didn't add much to the world's burgeoning store of knowledge. It did boost production and cure a lot of headaches.

**MY POINT WOULD BE** that we all need as much education as we can get. But education must go on in a meaningful way outside the classroom. It's management's job to provide the incentive and atmosphere for continuous learning, and practical creativity will surely follow. And our obsolete senior will have no problem. 747-H

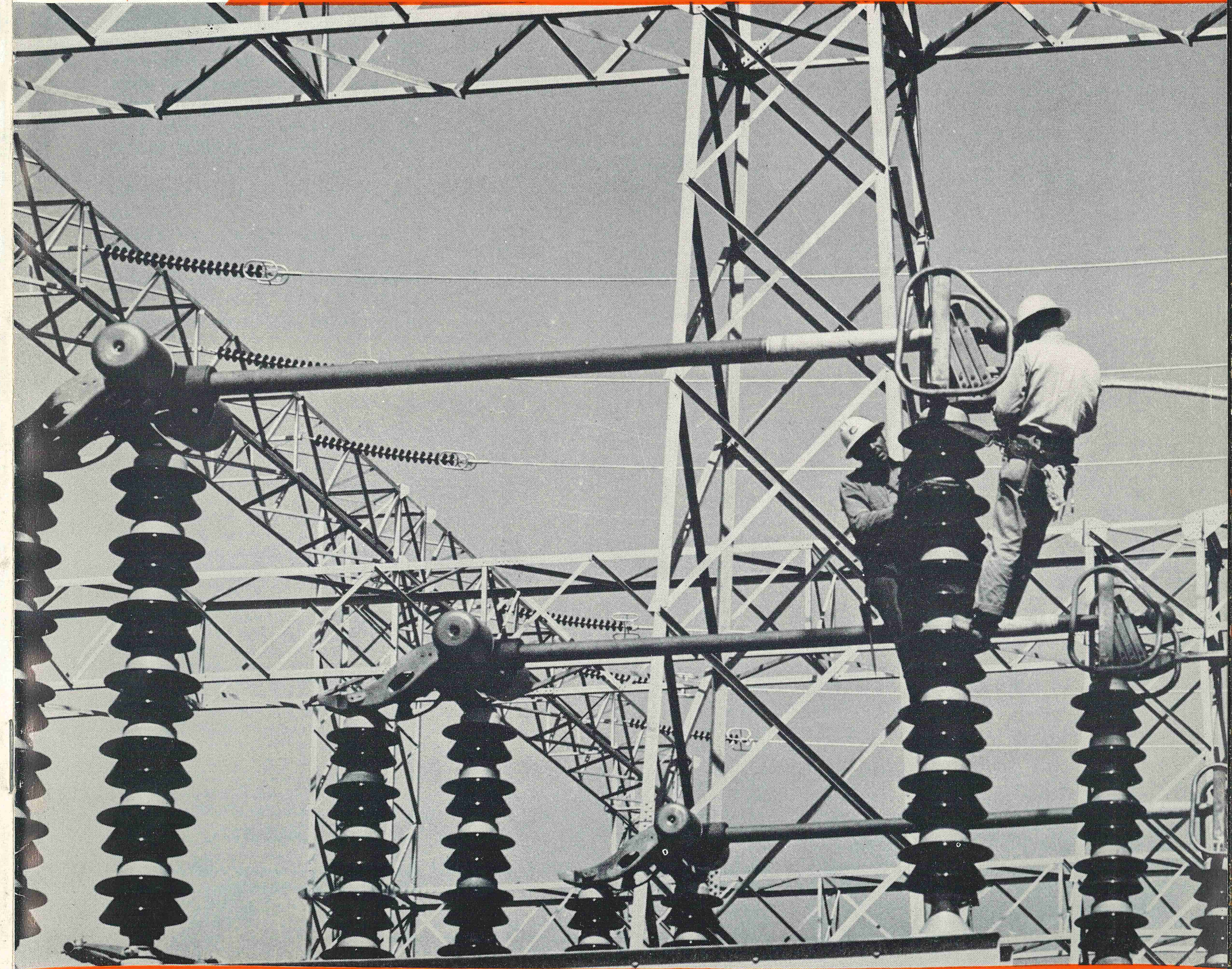
OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario

OHIO BRASS

6664-H Printed in U. S. A.

# Hi-Tension News

APRIL 1966



**Improved characteristics for O-B stacking pincaps**

# Compact construction with V-strings reduces cost of structures

## Resulting closer phase spacing also increases power-handling capacity of line

It sometimes happens that V-string construction of transmission lines saves so much land . . . and so many other items associated with land, such as clearing and maintenance . . . that another big category of savings is given only casual notice; namely, towers. Yet, on some EHV lines, V-strings have cut as much as a million dollars off this item. And, in doing it, they have increased the power-handling capacity of the system to gain even greater value.

Conductor restraint is the basic reason for the compact construction possible with V-strings. Because there is no sidesway at the tower, conductors may be permanently positioned at their minimum electrical clearance. This has its greatest effect on the center phase, permitting a radical reduction of size of the tower "window."

Such size reduction shortens the crossarm. Members may be reduced in weight and number. A shorter, lighter crossarm calls for corresponding economies in the leg portion. All told, a V-string tower will often fit well inside an equivalent tower for the support of free-swinging insulator strings, as the accompanying drawing shows.

Tower material must be moved to the right-of-way and later erected. Especially where long distances or rough terrain are involved, tons of tower can become a considerable factor in transportation. If structures must be flown in by helicopter, even pounds are important. And no matter how the tower arrives at its site it must be erected. Number of pieces and weight to be handled determine how many structures can be finished in a day. A host of details must be considered in the question of transportation and erection, but they favor the smaller V-string tower.

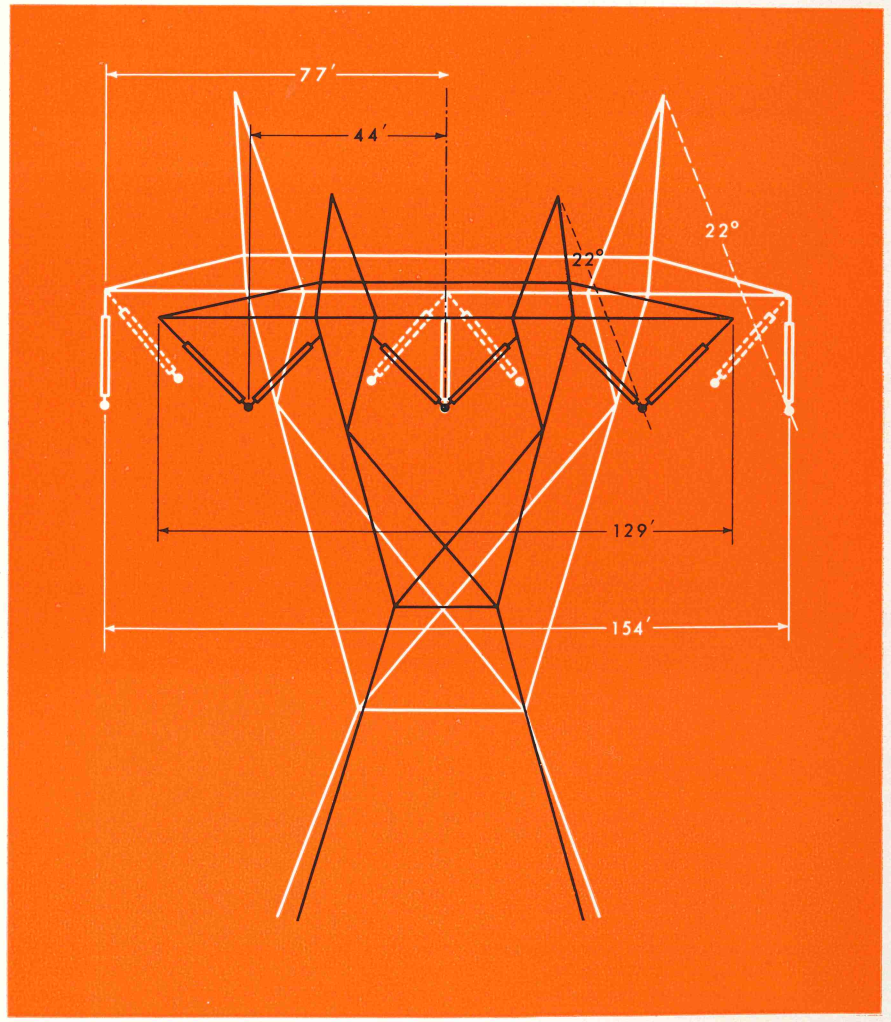
Naturally, there are so many variables in this question that we cannot present any general estimate of saving. From experience, however, a reduction of at least 10 per cent in erected tower cost is a reasonable expectation, and has often gone considerably higher.

Closer phase spacing, inherent with V-strings, produces a permanent improvement in power-handling capacity of a transmission line. Since most EHV projects are designed for maximum efficiency, this becomes a very attractive asset.

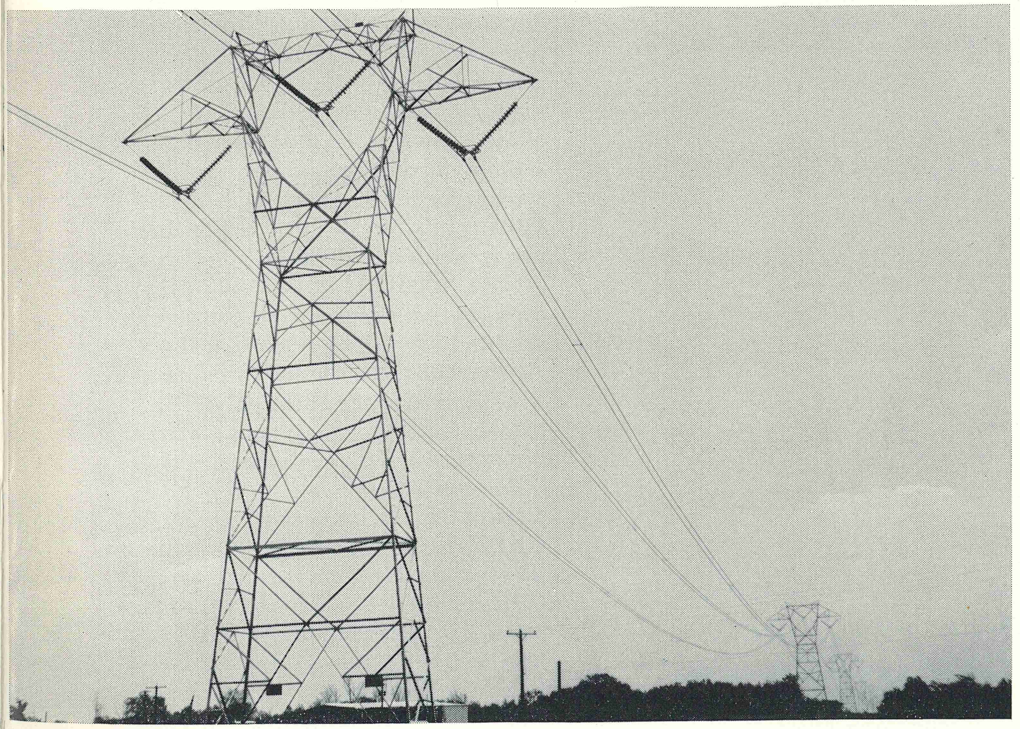
While resistance is present in any line, it is less of a factor at EHV levels than inductive reactance. Reactance imposes a limit on the amount of power a line will accept. Reactance is directly related to phase spacing . . . the closer the phases are positioned, the lower the reactance. With all other specifications the same, closely grouped phases will permit the line to handle materially more power. In the example of towers shown here, twin conductors at 500 kv will accept about six per cent more power with V-string construction.

To evaluate the effect of inductive reactance, the design details of an individual line must be considered. This can be done only by the engineers of the power company planning that line. It will be found, however, that the somewhat tedious calculation of inductive reactance will be well justified in a more realistic set of facts relative to the merits of V-strings vs free-swinging single insulator strings.

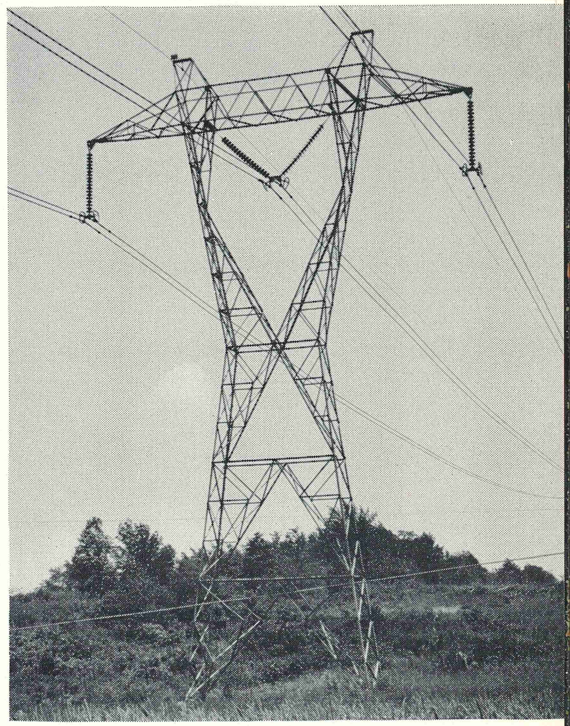
Tower designers will naturally be confronted with questions from their management regarding relative costs of the two kinds of construction. While they can be estimated accurately, there are a few generalities that may also be of interest. The three extra strings of insulators required for V-string construction can almost always be covered by the saving in tower cost . . . often several times over. Even where land is quite cheap, a reduction in right-of-way width of only 20 to 30 feet should defray the extra cost of insulation, and V-strings usually save more land than this (eight feet of right-of-way equals one acre per mile). Owners of a 500-kv line now under construction tell us that V-strings paid for themselves simply through reduced clearing cost. In short, your case will be exceptional if V-strings on a major EHV project do not show well over a million-dollar clear saving . . . plus the attractive prospect of delivering more power.




**LEFT** - With the same factors of electrical clearance and shielding angle, a typical schematic tower for single-string, free-swinging insulation (white) is superimposed on an equivalent tower for V-strings (black). This demonstrates the common assumption that a V-string tower will fit well inside its single-string counterpart in the majority of cases. Saving of material, weight, transportation and erection costs, through use of the smaller tower, are obvious. By reducing phase spacing from 77 to 44 feet, the line will have greater power-handling capacity as a result of lower inductive reactance.



**RIGHT** - Since this 345-kv line crosses large tracts of expensive suburban real estate, V-strings were used to their maximum advantage in restricting the right-of-way to only 100 feet. A second advantage in extremely compact towers is higher transmission efficiency.



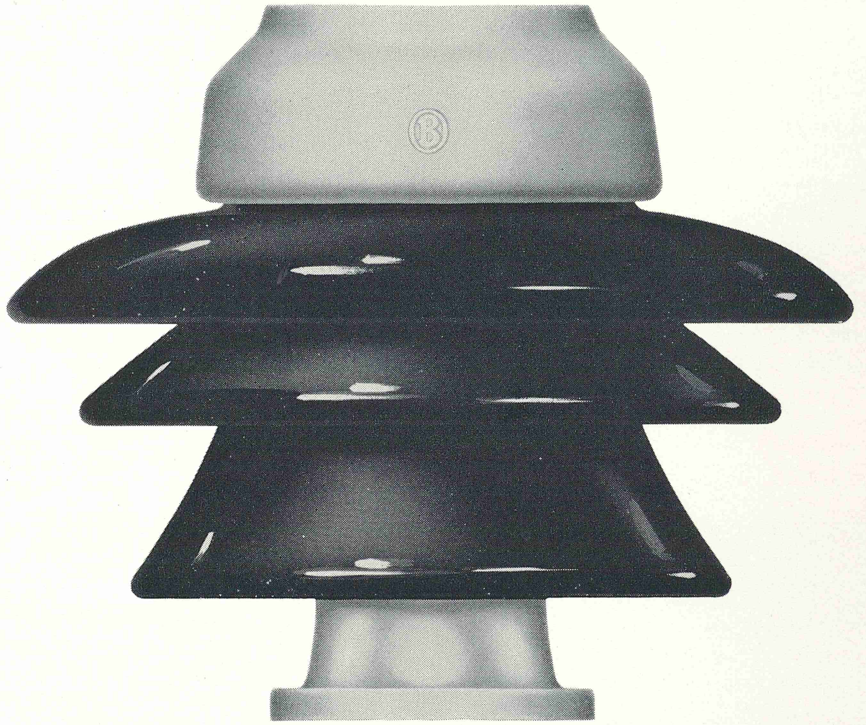
**FAR RIGHT** - As mentioned in the text, V-strings exert their principal effect on the size of the tower window to accommodate the center phase. Size and dimensions of this tower have been reduced with the employment of only one V-string.

OB Hi-Tension News
APR. 1966, VOL. 35, NO. 4

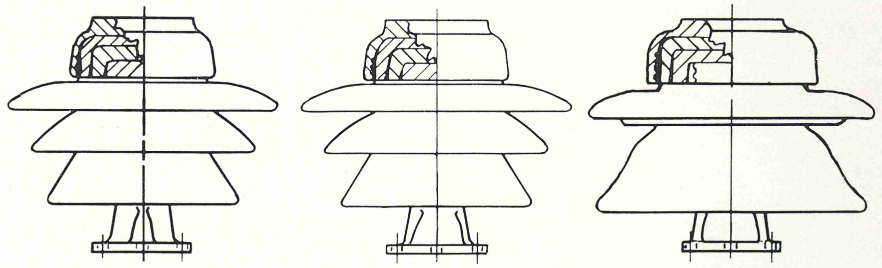
**ON THE COVER** - Uniform stacking arrangement of O-B pincap insulators at 345-kv substation simplifies maintenance requirements through station-wide interchangeability.

OHIO BRASS CO., MANSFIELD, OHIO

# Improved characteristics and availability of O-B high strength stacking pincaps broaden application possibilities



High-strength stacking pincap 43990 is three-skirted unit with alumina-body porcelain for increased mechanical and electrical rating.



31152 43990 30575

Pincap 43990, when used in mixed stacks, combines the desirable electrical characteristics of the 31152 insulator with the higher strength rating of the 30575 design.

High strength pincaps (O-B Catalog numbers 31152 and 43990) are at present available on reasonable delivery schedules for use in constructing substation insulation.

Under these circumstances, it is appropriate to review salient characteristics of pincap insulators, including several improvements which have become effective since specifications were last published. The inherent versatility of pincap insulators simplifies station planning through their convenience in adaptability to bus work and equipment. Cost, appearance, BIL ratings, cantilever strengths, and stack deflections can be extensively controlled by station planners through the many options which are available in the selection of uniform or mixed stacks of pincap insulators.

A particularly prominent example of the advantages to be gained through mixed stacks involves O-B's 43990 high-strength pincap insulator, which was announced several years ago as a design combination incorporating certain desirable stacking characteristics of standard pincap models 31152 and 30575. Since the introduction of the 43990 pincap, it has been recommended for use in place of the 30575 insulator in mixed stacks with 31152 units to achieve a substantial improvement in the stack's electrical characteristics. Equal cantilever strength is maintained and a significant savings in cost is realized.

Physical dimensions of the 43990 pincap insulator match those of the 31152 units, while the 30575 unit has a porcelain diameter one inch greater. Both 31152 and 43990 pincaps are of three-skirted construction and have inherent capacitance of 70 picofarads. The 30575 pincap is of two-skirted construction and has an inherent capacitance of approximately 135 picofarads.

Inherent capacitance of individual pincaps is an important factor in mixed stacks, because it determines the voltage division existing across individual units. Since the charging current is approximately equal (except for stray losses) for all units in an insulator stack, voltage across each unit is inversely proportional to the unit's inherent capacitance. Consequently, when a mixed stack of pincaps having the same capacitance is being considered, the electrical rating is not affected. Conversely, when a mixed stack incorporates pincaps having different capacitances, the electrical rating may be reduced when the high capacitance unit is used at the ground end.

Cantilever strength rating of the 31152 pincaps is substantially less than that of the 30575 units. This limitation has been overcome in the 43990 pincaps where the high-strength porcelain body of the three-shell construction is combined with heavier hardware to provide the same strength rating as the 30575 units.

Stack deflection values for the 43990 pincap insulator have been significantly improved since its introduction. Deflection ratings closely approach those of the 30575 units, as indicated in the tabulated characteristics to the right.

To summarize present data on 31152, 30575, and 43990 pincap insulators, some general comparisons can be made.

A uniform stack of 31152 pincaps still represents the lowest-priced option, but also carries the lowest strength rating and the highest deflection. Uniform stacks of 30575 and 43990 pincaps both have the highest strength rating, but the higher-cost 30575 pincaps are much heavier in weight and have only slightly less deflection.

Mixed stacks of 31152 and 30575 pincaps have the same cantilever strength ratings as corresponding mixed stacks of 31152 and 43990 pincaps, but the lower unit price of the 43990 insulators results in a definite cost advantage for the 43990 combinations. While the 30575 pincap combinations obtain better deflection ratings, it is also true that their higher inherent capacitance necessitates some reduction in stack BIL.

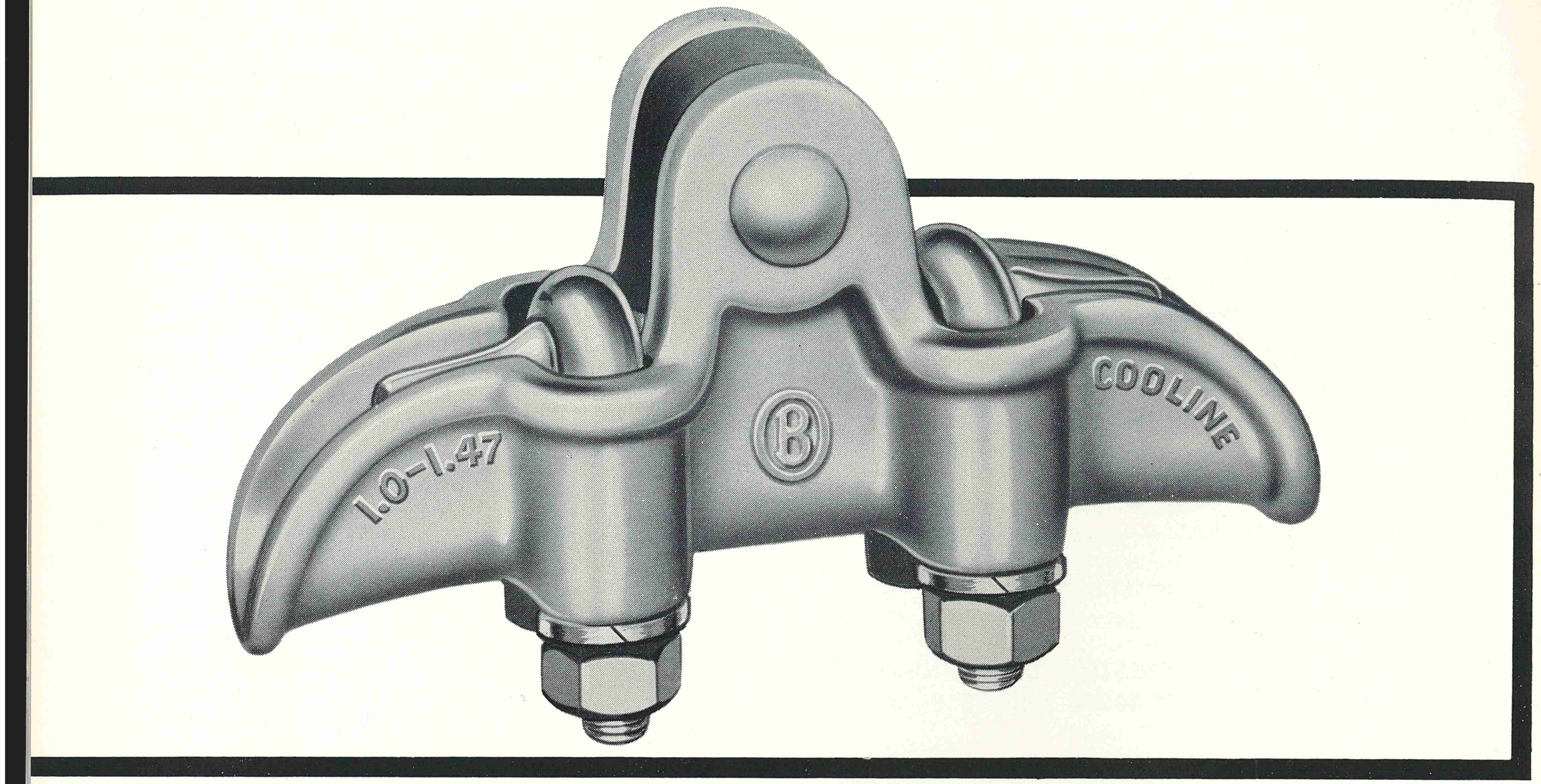
## CHARACTERISTICS OF A SINGLE UNIT NUMBER 43990 ARE AS FOLLOWS:

| | |
|---|---|
| BIL (Impulse withstand) | 210 kv. |
| Flashover voltage, 60 cycle, dry | 160 kv. |
| Flashover voltage, 60 cycle, wet | 95 kv. |
| Flashover voltage, impulse critical, positive | 235 kv. |
| Flashover voltage, impulse critical, negative | 290 kv. |
| 60-cycle withstand voltage, 1 min., dry | 115 kv. |
| 60-cycle withstand voltage, 10 sec., wet | 75 kv. |
| RIV, test voltage | 22 kv. |
| RIV, maximum microvolts at 1000 kc. | 100 mu-v. |
| 60-cycle oil puncture | 215 kv. |
| Cantilever strength, base mounted, upright | 10,000 lbs. |
| Cantilever strength, top mounted, underhung | 6,000 lbs. |
| Tensile strength | 25,000 lbs. |
| Torsion strength | 90,000 inch-lbs. |
| Compressive strength | 75,000 lbs. |
| Leakage distance | 33 inches |
| Dry arcing distance | 14¾ inches |
| Net weight | 85 lbs. |
| Packed weight | 99 lbs. |
| Bolt circle diameter | 5 inches |

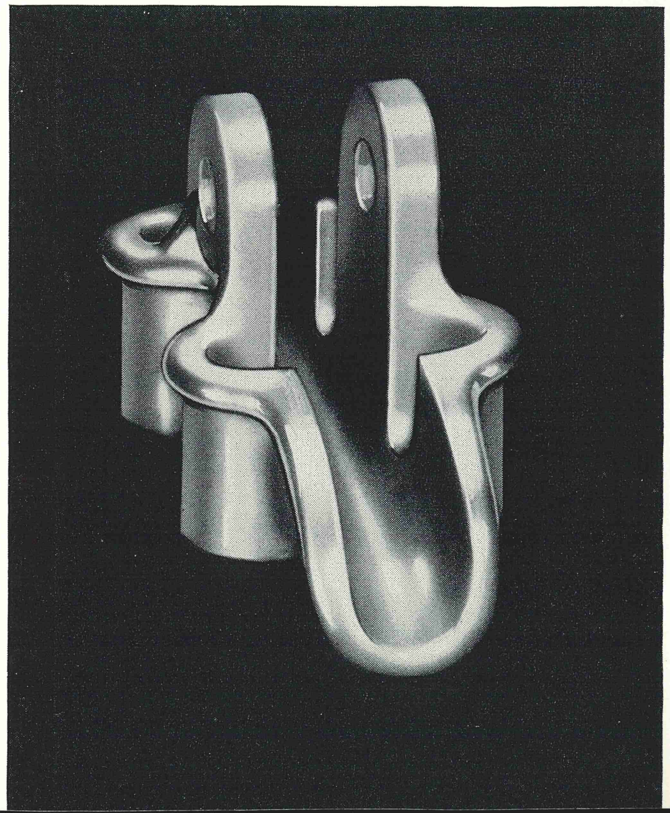
## TABULATION OF STACKING DATA 31152, 30575 AND 43990 PINCAPS

| Stack 31152 | Stack 30575 | Stack 43990 | BIL, kv. | Cantilever Strength lb. | Deflection in/100 lb. | Height, Inches |
|---|---|---|---|---|---|---|
| 2 | — | — | 350 | 3000 | .0110 | 32½ |
| 1 | 1 | — | 325 | 4500 | .0067 | 32½ |
| 1 | — | 1 | 350 | 4500 | .0081 | 32½ |
| — | 2 | — | 350 | 4500 | .0061 | 32½ |
| — | — | 2 | 350 | 4500 | .0077 | 32½ |
| 3 | — | — | 550 | 1700 | .035 | 47 |
| 2 | 1 | — | 525 | 2900 | .025 | 47 |
| 2 | — | 1 | 550 | 2900 | .028 | 47 |
| — | 3 | — | 550 | 2900 | .020 | 47 |
| — | — | 3 | 550 | 2900 | .025 | 47 |
| 4 | — | — | 750 | 1200 | .080 | 61½ |
| 3 | 1 | — | 725 | 1700 | .060 | 61½ |
| 3 | — | 1 | 750 | 1700 | .068 | 61½ |
| 2 | 2 | — | 710 | 2000 | .050 | 61½ |
| 2 | — | 2 | 750 | 2000 | .061 | 61½ |
| — | 4 | — | 750 | 2000 | .045 | 61½ |
| — | — | 4 | 750 | 2000 | .058 | 61½ |
| 5 | — | — | 900 | 910 | .150 | 76 |
| 4 | 1 | — | 875 | 1200 | .122 | 76 |
| 4 | — | 1 | 900 | 1200 | .132 | 76 |
| 3 | 2 | — | 860 | 1450 | .102 | 76 |
| 3 | — | 2 | 900 | 1450 | .120 | 76 |
| — | 5 | — | 900 | 1450 | .087 | 76 |
| — | — | 5 | 900 | 1450 | .110 | 76 |
| 6 | — | — | 1050 | 750 | .260 | 90½ |
| 5 | 1 | — | 1025 | 910 | .213 | 90½ |
| 5 | — | 1 | 1050 | 910 | .230 | 90½ |
| 4 | 2 | — | 1010 | 1170 | .185 | 90½ |
| 4 | — | 2 | 1050 | 1170 | .212 | 90½ |
| — | 6 | — | 1050 | 1170 | .150 | 90½ |
| — | — | 6 | 1050 | 1170 | .190 | 90½ |
| 7 | — | — | 1300 | 620 | .410 | 105 |
| 6 | 1 | — | 1275 | 750 | .340 | 105 |
| 6 | — | 1 | 1300 | 750 | .360 | 105 |
| 5 | 2 | — | 1260 | 910 | .293 | 105 |
| 5 | — | 2 | 1300 | 910 | .330 | 105 |
| 4 | 3 | — | 1230 | 1000 | .265 | 105 |
| 4 | — | 3 | 1300 | 1000 | .312 | 105 |
| — | 7 | — | 1300 | 1000 | .230 | 105 |
| — | — | 7 | 1300 | 1000 | .290 | 105 |
| 8 | — | — | 1470 | 525 | .600 | 119½ |
| 7 | 1 | — | 1445 | 620 | .520 | 119½ |
| 7 | — | 1 | 1470 | 620 | .550 | 119½ |
| 6 | 2 | — | 1430 | 750 | .450 | 119½ |
| 6 | — | 2 | 1470 | 750 | .500 | 119½ |
| 5 | 3 | — | 1400 | 900 | .403 | 119½ |
| 5 | — | 3 | 1470 | 900 | .470 | 119½ |
| — | 8 | — | 1470 | 900 | .340 | 119½ |
| — | — | 8 | 1470 | 900 | .430 | 119½ |

# O-B offers investment insurance for $3.50

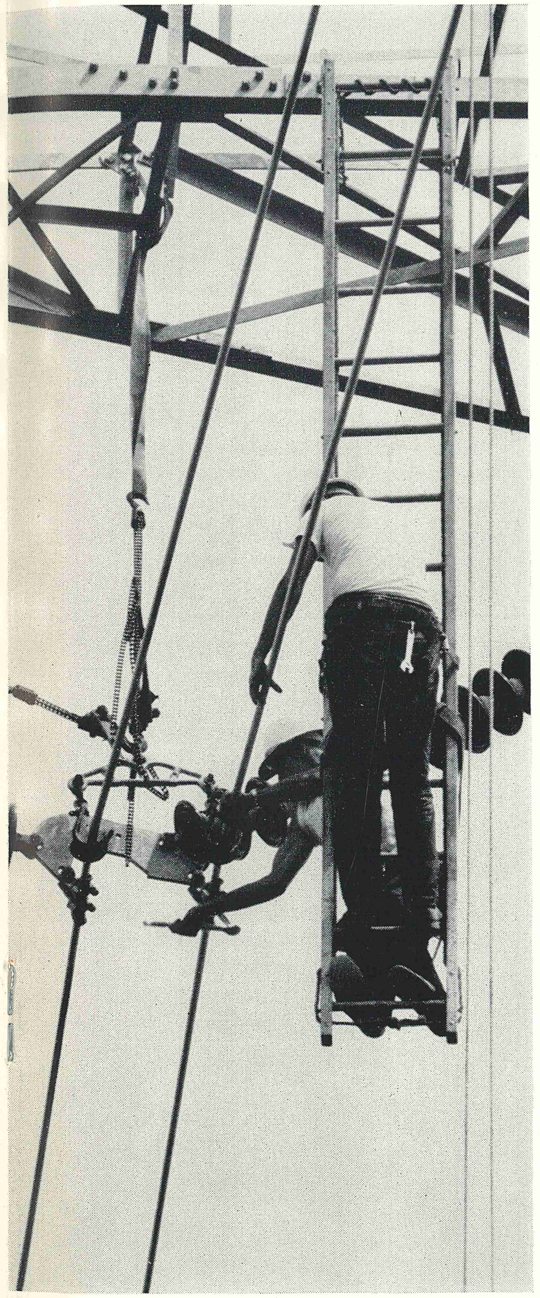



▲ Here's O-B's $3.50 power-line investment insurance - the regular Cooline^R suspension clamp. It's the one conductor support for all power systems from 34.5 to 345 kv.



◀ Casting of all O-B Cooline^R suspension clamps in modern manufacturing facilities results in consistent reproduction of the controlled-radius design to assure you optimum performance on your line.

Linemen need no special training or tools to install O-B's regular Cooline^R suspension clamps. Here they tighten the clamp securely with a socket wrench at an angle position on a midwest 345,000-volt transmission line . ▶



Would you invest $3.50 to protect your power-line investment at each support point? That's the price of the average-size O-B Cooline^R suspension clamp to support power systems from 34.5 to 345 kv. Let's take a look at what you get for your $3.50.

First, you get your money back! Cooline^R clamps are nonmagnetic, cast of either bronze or aluminum. Hysteresis or eddy current losses, which cause heating in ferrous clamps, are reduced to a negligible level. Your clamp and conductor remain cool, power losses are substantially reduced, and transmission efficiency is increased when you install O-B's Cooline^R suspension clamps. Savings derived from the increased power delivered at receiving end will often pay for the complete cost of the clamps two or three times during the life of the line.

Another form of built-in insurance furnished by O-B Cooline^R suspension clamps is the controlled-radius design. During the past 50 years, O-B engineers made detailed studies of clamp requirements and performance under normal, static, and dynamic loading conditions on hundreds of lines at all voltages. These studies revealed the design criteria for the optimum clamp to match the performance requirements of almost all lines, and resulted in development of O-B's exclusive controlled-radius design principles. Now, the O-B development engineer checks your line's requirements when he receives your order to make certain the O-B clamp you selected has the correct seat size, seat radius, and take-off angle to fit your needs. Basically, your O-B clamp is matched with your line to assure optimum performance. And, you get the additional benefit of a performance-proved clamp with known reliability because O-B Cooline^R clamps have a 15-year history of successful operation.

A third type of investment insurance is found in the manufacture of O-B's Cooline^R clamps. Both aluminum and bronze types are cast in modern manufacturing facilities. Rigid quality control and inspection during the manufacture and finishing of Cooline^R clamps insure delivery of a smooth-surfaced cradle to fit your exact conductor size and line requirements.

Use of steel, permanent molds in casting O-B's aluminum suspension clamps results in consistent design reproduction time after time. Controlled cooling and heat treating assure uniform metallurgical structure throughout each clamp for maximum strength. And, application of a quality aluminum clamp to your aluminum conductor prevents electrolytic action which can occur between dissimilar metals.

All Cooline^R clamp keeperpieces are also designed and manufactured to fit a specific range of conductor sizes, and receive the same careful inspection before shipment. Clamp and keeperpiece fit together naturally to form a snug fit with the conductor. Close fit between clamp, conductor, and keeperpiece assures uniform distribution of keeper pressure to prevent distortion of conductor strands — additional insurance to protect your investment.

Installation of O-B's regular Cooline^R suspension clamps is convenient and simple. Your linemen need no special tools or training to make a correct and permanent attachment of clamp to conductor. Four large U-bolts in the keeperpiece fit into four holes in the clamp body. One lockwasher and one rounded nut are threaded on each bolt protruding through the clamp body, then snugged tight with a socket wrench to complete the installation. Marking each clamp body with its appropriate conductor size protects against accidental installation of the wrong clamp.

If you're in the planning stages of construction on a line from 34.5 to 345 kv, pull out your O-B Transmission & Distribution Hardware Catalog 44. Turn to page 10 and check which O-B clamp fits your needs. (Ultimate strength ratings range from 18,000 to 25,000 pounds.) If you have questions, call your Ohio Brass district manager. He'll be glad to help you select the exact performance-proved O-B suspension clamp to protect your line — and O-B yokes, fittings, insulators.

# This is our biggest investment in pessimism

## Facilities are available to test Thorex arresters for an event that might happen once in 14,300 years

Lightning arresters have recently become such an important factor in switching surge control on EHV systems that their basic function . . . lightning protection . . . is taken for granted by many users. This is all right, providing O-B doesn't take it for granted. How do you test for severe lightning attack . . . do you actually make lightning? The answer is "yes."

If simulated lightning is used for arrester testing, what should be its magnitude? This question falls into the general category of service duty testing, involving high-current, short-duration impulse discharges. Arrester class . . . distribution, intermediate, or station . . . and to some extent, voltage rating within its class, determines the maximum testing current applied to an individual specimen. This is guided by a highly accepted and dependable body of statistical data. At the far end of this data, it recognizes the possibility of an arrester being subjected to 100,000 amperes of lightning current once in 14,300 years.

It may be considered ultra-pessimistic that we installed in the O-B High Voltage Laboratory a special impulse generator capable of delivering more than 100,000 amperes. Whenever production of such a massive test discharge is required, it is simply a matter of adjusting the generator circuit. The equipment to perform such tests is not only quite specialized but has been of considerable interest to laboratory visitors.

To start with, it would be highly impractical to produce these currents with any conventional form of research surge generator. Such requirements don't fit the concept of this type of generator. And even if a piece of all-purpose equipment were available, it would be monopolized for lengthy periods in arrester testing and prevented from working on a busy schedule of EHV transmission studies. For these reasons, a separate generator was built, including its own special power supply and instrumentation.

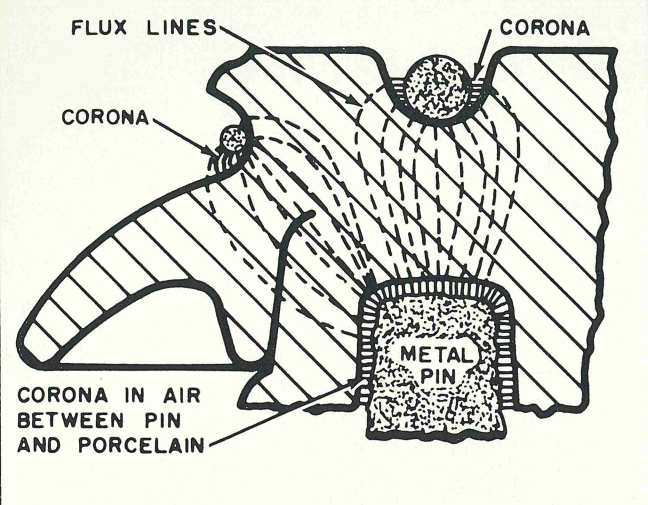
Especially when working in the range of its maximum output, the discharge of this generator is impressive. The noise is like heavy artillery. Specimens under intentional destructive test fail with explosive violence, propelling fragments at dangerous velocity. To control noise and confine debris, a strong enclosure completely surrounds the test stand. Its deeply scarred walls attest to its value. These same walls help reduce noise.

Another advantage of the enclosure is the natural center it forms for the closely clustered high-current capacitors that completely surround the structure and keep length of leads at a minimum.

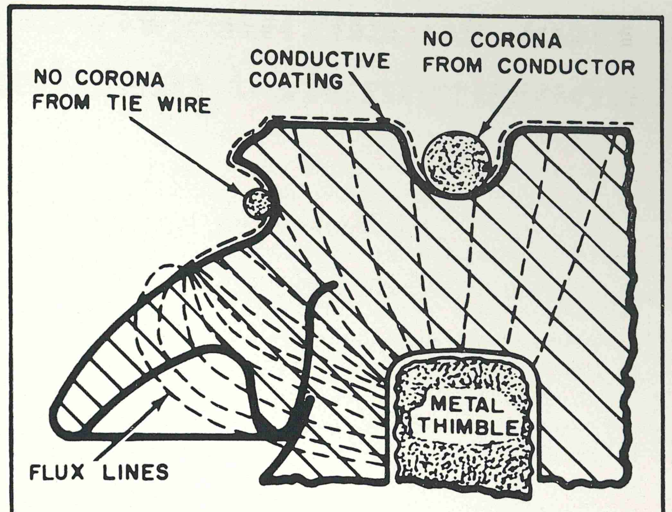
Most of us find it difficult to visualize 100,000 amperes in terms of force . . . it is simply a lot of amperes. An interesting phenomenon of this generator suggests some of the unsuspected forces involved. For test connections, heavy flexible copper braid is used. This material is woven cylindrically and then pressed flat. A single discharge causes the piece of braid conducting the current to expand back to its hollow cylindrical form.

When laboratory visitors ask us what this generator is for, we sometimes explain it is our biggest investment in downright pessimism . . . it can duplicate an event that might occur once in 14,300 years.

Lightning discharges as high as 100,000 amperes may be produced on this special impulse generator for testing arresters in the O-B High Voltage Laboratory. The heavy enclosure around the test stand reduces the almost deafening noise and confines flying particles during destructive tests.




On ordinary pintype insulators, an electrostatic field forms between the conductor, tie wire, and metal pin which develops stress concentration at tie wire and conductor to produce excessive RIV and corona.




After application of O-B's Number 608 Conduction Paint, the electrostatic field is distributed over a broader area to reduce RIV and eliminate corona when the line is energized.

# Modernize "old" insulators with O-B's number 608 conduction paint

During a recent modernization program of distribution lines, one O-B customer removed old pintype insulators which produced high RIV levels after he raised his primary distribution voltage. The insulators had adequate dielectric strength, but incipient arcing produced excessive RIV and corona. Naturally, he couldn't justify discarding several hundred insulators, so he presented his problem to his O-B district manager.

Recognizing the "troublesome" pintypes as pre-Silentype units without conduction glaze, the O-B district manager directed his customer to Page 17 of O-B T&D Insulator Catalog 42. Listed there is the solution to excessive RIV on older insulators -- O-B Number 608 Conduction Paint. Applied to the pinhole and head of an old pintype insulator, Number 608 Conduction Paint substantially reduces generated RIV on the insulators to levels comparable with units having conduction glaze.

When an insulator is installed on a line and energized, a difference of potential exists between the metal pin, conductor, and tie wire to produce an electrostatic field. This field tends to be intense at the contact points on the insulator to produce high RIV levels and corona. On modern O-B pintype insulators, the Silentype conduction glaze covers the insulator head and pinhole to distribute the stress over a broader area and reduce the concentration. O-B's Number 608 Conduction Paint does the same thing for old insulators made before development of the Silentype glaze.

Covering the head section and pinhole of old pintypes with Number 608 paint results in a conductive coating which will eliminate excessive RIV and corona. Number 608 paint adheres closely to the insulator surface and will not chip, peel, or form spots to develop a stress point. To coat a unit, use a brush or "swab-like" instrument dipped into the paint and apply to the head portion of the insulator. Taper the coating off a little less than halfway down the insulator's top surface to prevent an abrupt end to the conductive portion of the unit. Then, coat the upper half of the pinhole thoroughly. Let the units dry for several hours, and put them back up on the job.

Convert your old insulators for use on today's higher-voltage distribution lines. Order O-B's Number 608 Conduction Paint from your O-B district manager. And, order Number 608 solvent to clean brushes and remove any unwanted spots from your pintypes. Ask your O-B district manager for further information, or write: Ohio Brass Company, 380 North Main Street, Mansfield, Ohio 44902.

O-B's Number 608 Conduction Paint is available in quart and gallon cans, clearly labeled for easy identification. Number 608 solvent comes in pint and quart cans, and permits removal of unwanted spots from insulators and excess paint from brushes.

# How to cut the trouble and cost of contaminated distribution insulators

How much does it cost to clean contaminated insulators on a distribution system? There are dozens of answers, depending on severity of the trouble, how much is charged directly against the job, and what is absorbed in miscellaneous expenses. But, however you account for it, the money must be spent.

Three pieces of equipment are necessary: a high-pressure jetting pump with special hose and nozzle, a water supply such as a tank trailer, and some type of safe aerial equipment to put men up to their work. If the full hourly charge for this equipment is allocated to the job, it could easily amount to $25 per pole, perhaps more.

Wages for drivers, ground crew, and linemen may come close to equaling that figure.

To be coldly realistic we tried the question in a different way. Ignoring all charges for equipment, and assuming wages for only four men, could the equipment be moved from pole to pole, the work bucket positioned, and insulators cleaned for $10 per pole? This was asked the O-B Live Line Department which has efficient equipment and intimate knowledge of the work. The answer was, "We'd hate to promise it, let alone maintain this rate for a full day."

Regardless of cost, however, when leakage begins to occur over the surface of a contaminated insulator, it is no longer a question of do we or don't we clean them. It's only a matter of WHEN do we clean them?

It is the word "when" that we would like to explore in somewhat more detail, because "when" is closely related to the expenditure of money.

Various measures have been tried to postpone or possibly eliminate cleaning of distribution pintype insulators. One of these is over-insulation. Larger insulators, rated three or four times normal line voltage, have longer leakage surfaces and deeper petticoats. For moderate contamination these may establish sufficiently long paths so that critical surface leakage may never develop, or at least develop very slowly. This, of course, is importantly aided by clean, relatively dry areas up under the petticoats, which limit the flow of surface leakage currents.

Many factors influence the economy of over-insulation: magnitude and tenacity of the contamination, and degree of conductivity of the deposit. There is little point to buying only a minor improvement with a major increase in insulation cost. But over-insulation has worked admirably in some cases, and is well worth a modest experiment.

Another measure, dependent somewhat on the nature of the contaminant, is the use of post-type insulators. The post has the advantage of fully exposed surfaces which lend themselves to natural rain washing. If the deposit is soluble in rain, this design can be very effective. If not, the fully exposed surfaces become totally coated and constitute an unrelieved leakage path. It must be realized that unusually long leakage length can be obtained quite readily in a post, but if the surface becomes uniformly contaminated with a tenacious, conductive film, even this extra length loses much of its value.

Some utilities follow the practice of changing-out contaminated insulators, cleaning them, and returning them to stores. This cleaning is done by shop labor. Granted this requires less mechanical equipment and fewer men on the job, but it is doubtful if all the insulation on two poles per hour can be changed-out, hot, including allowance for time in transferring and repositioning aerial equipment. Again, members of the O-B Live Line Department didn't care to commit themselves to any complete change-out figure as low as $10 per pole.

It is reasonable, and probably conservative, to say that $10 per pole represents a very low "par for the course" in dealing with contaminated insulators. And this may be repeated at frequent intervals.

At 7.2 kv, for an additional insulation cost of $3.21 per pole and at 13.2 kv, for an additional insulation cost of $8.37 per pole, the problem of cleaning can be considerably postponed, and stands a fair chance of being eliminated. This is done by the use of Fogbowl insulators. If they can save only one cleaning operation, their cost will be recovered. Actually they may never require cleaning, but, under the worst of conditions, they will extend periods between needed attention and thus save many times their purchase price.

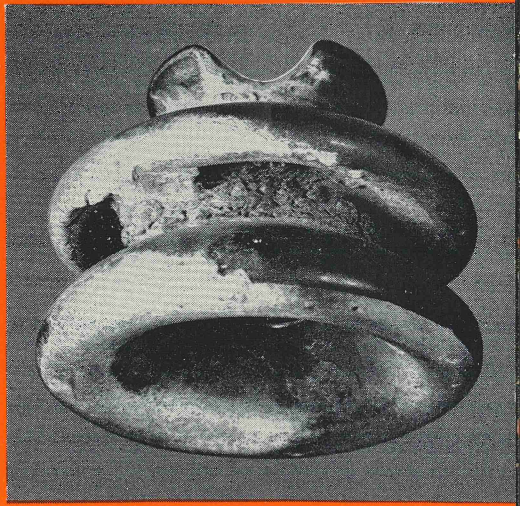
Fogbowls consist, basically, of a pintype insulator completely surrounded by an integral porcelain shroud. This shroud provides effective protection for the insulation underneath. Contamination on the outer surface of the shroud is harmless. It is difficult for deposits to form on the protected portions of the insulator. Even if some freak wind condition might eventually result in contaminated inner surfaces, it would be a very slow process. And even so, these surfaces would remain dry because of the complete shield provided by the shroud.

We in the insulator business have lived so close to the problem of contamination that we are the first to admit a universal cure-all has yet to be invented.

In most cases, however, contamination can be brought under tolerable control. Various operators prefer various methods which are sometimes dictated by nature of the contamination . . . primarily whether it will yield to the washing action of rain. This factor can control consideration of over-size insulation or the use of posts. In more severe cases the Fogbowl insulator offers effective relief.

"What do you do in a case like this?", is a question that can keep an insulator manufacturer awake nights. After a relatively few months exposure to cement dust, this condition developed. Perhaps a delaying action might be fought with gross over-insulation. Because of its total exposure, a post type would offer no solution. It would probably be ultimately the most economical to acquire the necessary land and relocate the line to the windward side of the source of contamination.

A less severe cement deposit. Over-insulation in this case might be relatively effective in extending the time of insulator replacement (this contamination would not yield to ordinary field cleaning). As a substitute for extra insulation, the Fogbowl would likewise delay, but probably not eliminate, attention.



While the low voltage involved resulted in relatively minor trouble, a condition such as this offers a severe hazard. Here, the contaminant is asbestos fibres that adhere tenaciously and become conductive when wet. Multiple disc-type dead-end insulators that would provide almost infinite over-insulation would probably extend cleaning periods, but relocation of the construction would be the only permanent cure.

Contamination of the more conventional type. This consists of a film of deposit which, if washable, would indicate the use of post-type insulation. If the contamination were not too conductive, even though not washable, an over-size post might impose sufficient leakage distance to keep trouble under control for long periods. Insulators such as this are sometimes removed and brought in for shop cleaning. The Fowbowl would increase freedom from trouble.

Check-out of 12470-volt shopping center feeder line uncovers burned connectors before they've caused television interference or power outage.

Linemen install by-pass jumpers, putting burned connectors out of service until permanent repairs can be made.

vide special capabilities of the aerial device and its crew.

*1:25 P.M. — Inspection Pays Off.* Fast routine inspections, made possible with the aid of MN-517 often uncover troublesome situations before power outages occur. In this case, the check-out of an air switch, on the 12470-volt primary feeder for a shopping center, reveals poor contact in the connector between the switch and primary line.

Natural deterioration of the joint between connector and conductor cable caused the trouble. Audible sputtering drew the serviceman's attention to it. The discovery and disposal of a potential trouble source, a bird's nest, is a bonus benefit from the inspection.

*1:40 P.M. — Temporary Repairs.* Using the aerial unit, the trouble shooting crew makes temporary repairs to prevent complete burn-out and power interruption. All three phases of the power line show signs of deterioration. The decision is made to install by-pass jumpers and "cut out" faulty connections until they can be replaced at a later date.

Total time at the site, including a wait for by-pass jumpers to be delivered by another crew, is about two hours.

*3:45 P.M. — The Homestretch.* MN-517 rounds out the work day assisting another line crew with a construction job.

## Systematic Inspection and Maintenance Keep Aerial Units in First Class Condition

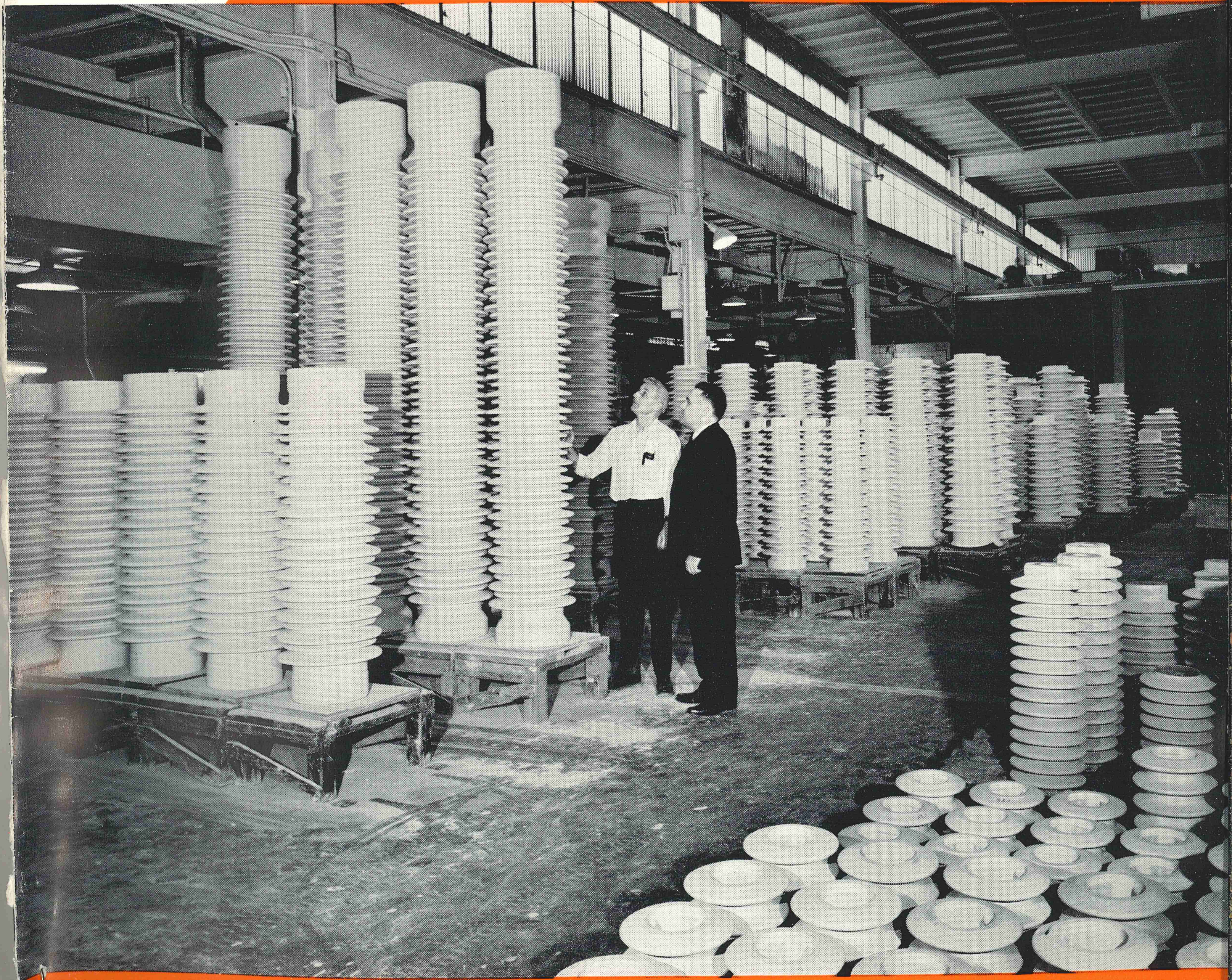
MN-517 and other Holan aerial devices at Ohio Edison's Mansfield line section are kept in first-class operating condition for top performance. An inspection form, completed at the beginning of every work shift, provides a day-to-day record of equipment condition. These systems and components are given special attention:

- Hydraulic Connections
- Hydraulic Hose
- Chain Drive
- Boom Condition
- Bucket Condition
- Operating Levers
- Emergency Switches
- Boom Drift
- Welds
- Battery and Lights
- Brakes
- Tires

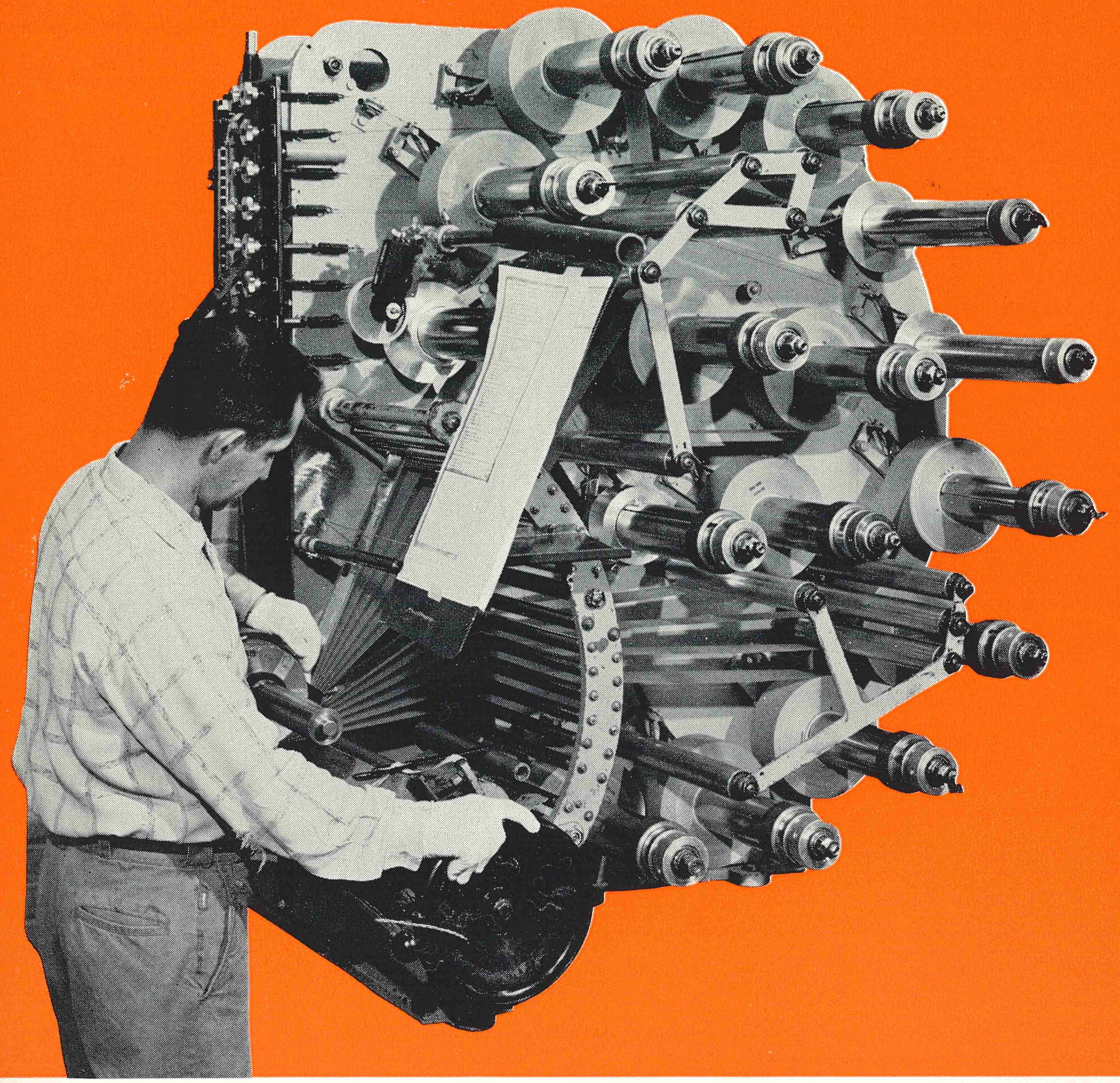


# O-B Hi-Tension News

AUGUST 1966

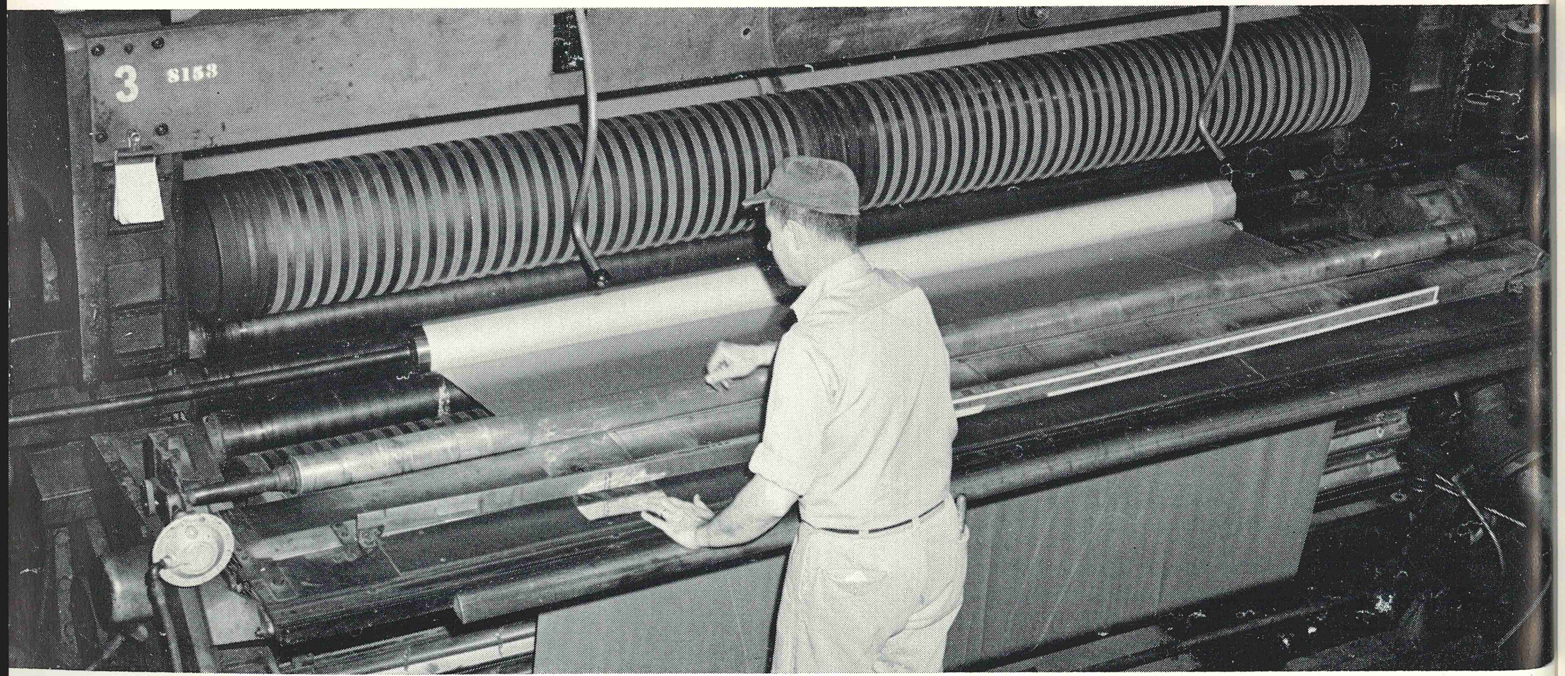


Potheads share critical techniques developed for several other related O-B products - - See page 2.



Left: One of the machines used in daily production of O-B Varex capacitors required no further revision than substitution of the narrow rolls of paper and foil to produce the special "doughnut" capacitors for potheads. The operator has had years of experience in capacitor winding. Long ago, human and mechanical "bugs" were worked out of production. O-B potheads inherit this valuable background.

Below: Supporting tubes for the many internal parts, and the all-important stress cone, are wound on the same machines and by the same experienced operators who produce bushing cores. Since the techniques are similar, O-B potheads are benefitted by a priceless background of mass manufacture.




OB Hi-Tension News
AUG. 1966, VOL. 35, NO. 8

**ON THE COVER** - Huge pothead porcelains . . . difficult to fire in the kilns . . . enjoy the experience gained from producing bushing and lightning arrester housings of comparable size.

OHIO BRASS COMPANY
MANSFIELD, OHIO 44902

# Potheads are brothers of bushings and capacitors . . . at O-B they inherit many family traits

Of all insulation on a power system, the high-voltage underground cable terminal (pothead) is probably the most critical from a standpoint of design and manufacturing techniques. Where the ground shield and insulation of the cable are sharply terminated we encounter an abrupt electrical discontinuity. Controlling the high concentration of electrical stress at this point requires skillful handling of ground potential, oil-paper insulation, and grading capacitance within the pothead structure. The job demands a combination of design knowledge and manufacturing skills. Experience and facilities loom very large in such a picture.

In the entire electrical industry, Ohio Brass is the only full-scale manufacturer of potheads, bushings, and capacitors . . . the only place where these three "prima donnas" of power transmission live together as members of the same family and, therefore, have the unique advantage of inheriting a host of family traits.

What do capacitors contribute? Machines that regularly wind O-B power capacitors simply require different rolls of paper and foil to produce the special "doughnut" capacitors required for potheads. Design and performance of these machines has been conclusively confirmed by making thousands of capacitors that passed laboratory tests, routine factory inspection, and have adequately met operating requirements over an extended period of time. The men who build capacitors for potheads are handling completely familiar materials. Long ago they learned the many little tricks of doing their job well. Equipment, materials, and skills have all been thoroughly tried out and are combined with much experience.

O-B has engineers who specialize in the design and production of a full range of capacitors. This knowledge has been applied directly to potheads . . . an asset that a single-product supplier would find difficult to duplicate.

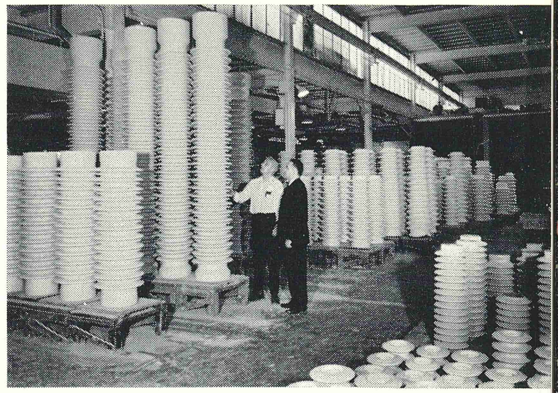
Bushings also make a big contribution to potheads. Years ago, when O-B started using oil-impregnated paper as a bushing dielectric, the saying got started, "It's a lot easier to make bushings ON paper than WITH paper!" But, in time, the critical techniques of paper insulation were mastered. Service records of O-B bushings so manufactured have set an entirely new standard of dependability. Knowledge of paper, as a material . . . how to wind paper . . . how to dry it . . . how to impregnate it . . . and how to test paper dielectric to be sure everything you did was right . . . is all at hand in the bushing department. In this department, with the same men, and on the same machines that wind and finish bushing cores, O-B pothead insulation is also produced.

Bushings, and more recently large lightning arresters, have made another contribution to pothead manufacture. For well over 50 years O-B has produced the massive porcelain cones for high-voltage bushings and, for the last 15 years, comparably heavy housings for large arresters. Making such huge porcelain pieces is a highly specialized branch of the ceramic art. Some of these pieces are very costly, and producing them without ruinous losses adds to the responsibility imposed on ceramic engineers. Obviously, good techniques in this category have a profound effect on selling price and deliveries. All this valuable porcelain manufacturing background has been inherited by potheads.

Just like bushings, potheads must contain hot oil without a trace of leakage. One of the big hurdles that was overcome in the development of a new bushing was the proper combination of materials and methods to produce a permanent seal. The men who devised the excellent sealing practice used in O-B bushings attacked the problem of sealing potheads with the feeling of being back home. The secure seal in the O-B pothead is the outcome of much closely parallel experience.

While a pothead presents many new problems to the development engineer, it likewise presents many old ones if that engineer has had O-B training. Certainly, one of the factors in the present ingenious design is complete familiarity with the whys and wherefores of associated products.

When you equip your underground cables with O-B potheads you are exploiting the advantage of dealing with a manufacturer intimately acquainted with the design and production of a whole related family of electrical equipment. Only from O-B can you obtain this over-all experience.



Perhaps we might label this picture "A day in the finishing department." The men are examining unfired porcelain pothead housings for 345-kv apparatus. Surrounding these housings are others for lightning arresters and bushings, as well as a host of smaller shapes. The massive unjointed porcelain pieces for potheads are extremely difficult to produce and to fire through the kilns. Daily experience with similar production for other O-B equipment is exceptionally valuable here.

# Specialized Smogtype unit intended for high-contamination locations

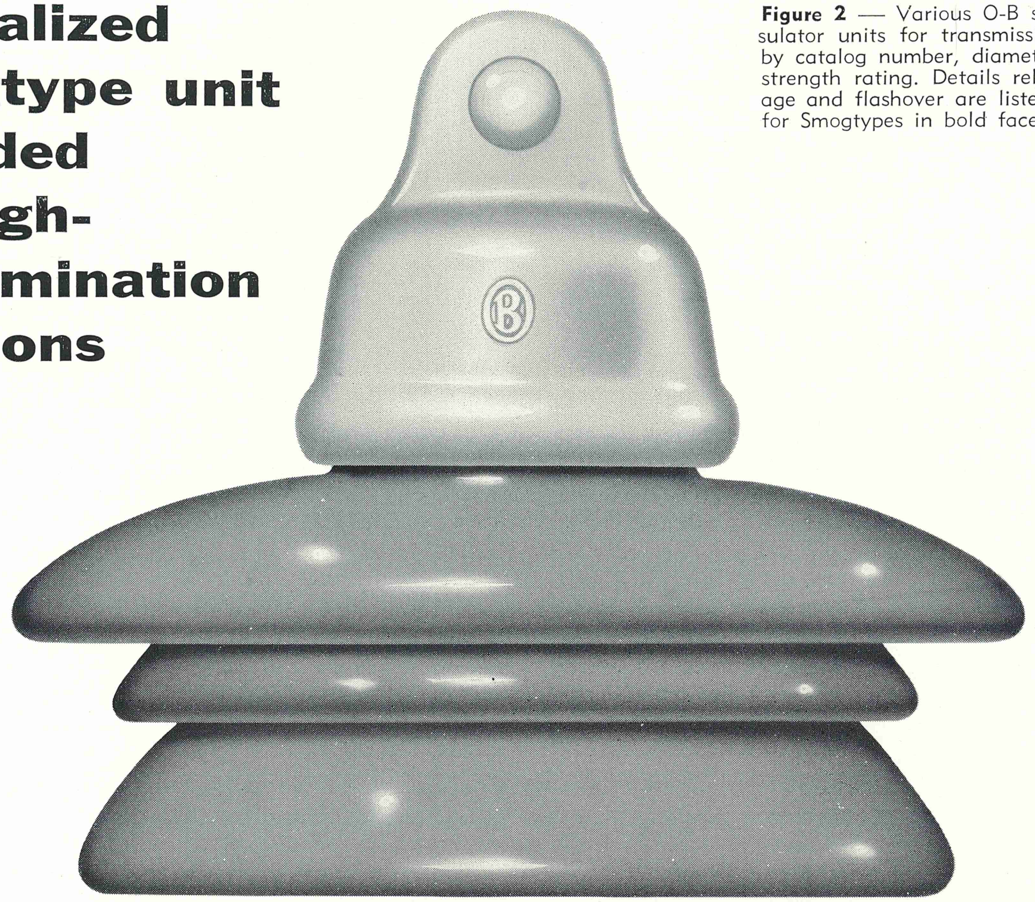


**Figure 2** — Various O-B suspension insulator units for transmission identified by catalog number, diameter, and M&E strength rating. Details related to leakage and flashover are listed, with those for Smogtypes in bold face type.

While representing a small percentage of total insulator usage the Smogtype suspension unit fills a specific need. A utility engineer recently asked us to enumerate the differences between conventional insulators and Smogtypes, and to review the advantages of the latter design, since he suspected he may have been overlooking an opportunity to improve the performance of one of his lines.

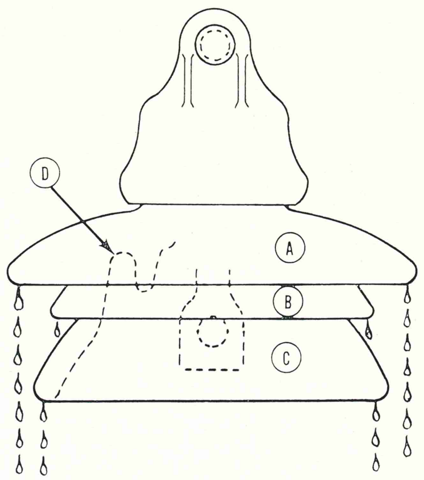



**Figure 1** — Deeply drooped petticoats (A) and (B) tend to produce clean, dry areas on the undersides. These areas are in series electrically and are highly effective in combating contamination leakage. The extremely deep underside of petticoat (C) resists contamination deposits and remains permanently dry, thus constituting the major barrier to leakage, reinforced by the other two areas. Unequal shell diameters aid in breaking up drip water and preventing cascading in heavy downpours.

Smogtype insulators are primarily intended for cases of above-average contamination. While they have extended leakage length, if mere leakage is the object, it can be bought for less money per inch with conventional suspension units. Conversely, if over-all string length is limited and greater leakage within this restricted length is desired, the Smogtype will add five or six inches more per unit. Choice between these alternatives must be made by the line designer.

In matters of contamination, leakage length is not the whole story. An accumulation of conductive deposit can short out and largely neutralize the resistance of exposed surfaces, no matter how long they are extended. Contamination trouble is best combated by clean, relatively dry surfaces; the more such surfaces occurring in series, the better.

Petticoats (A) and (B) in Figure 1 will be seen to have deep



| CATALOG NUMBER | PORCELAIN DIAMETER INCHES | M & E STRENGTH POUNDS | SECTION LENGTH 5″ | 5¾″ | 6⅛″ | 6¼″ | 6½″ | 7″ | ELECTRICAL LEAKAGE DISTANCE INCHES | FLASHOVER 60 CYCLE DRY KV | WET KV | IMPULSE POS KV | NEG KV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CONVENTIONAL TYPE** Ball-Socket | | | | | | | | | | | | | |
| 32436 | 10 | 15,000 | ● | | | | | | 11½ | 80 | 50 | 125 | 130 |
| 32440 | 10 | 15,000 | | ● | | | | | 11½ | 80 | 50 | 125 | 130 |
| 34500 | 10 | 15,000 | | ● | | | | | 11 | 80 | 50 | 125 | 130 |
| 48008 | 9½ | 14,000 | | ● | | | | | 11½ | 80 | 50 | 125 | 130 |
| 48058 | 9½ | 14,000 | | ● | | | | | 11½ | 80 | 50 | 125 | 130 |
| Clevis | | | | | | | | | | | | | |
| 32439 | 10 | 15,000 | | ● | | | | | 11½ | 80 | 50 | 125 | 130 |
| 35301 | 10 | 15,000 | | ● | | | | | 11 | 80 | 50 | 125 | 130 |
| 48019 | 9½ | 14,000 | | ● | | | | | 11½ | 80 | 50 | 125 | 130 |
| (Futura Series) Ball-Socket | | | | | | | | | | | | | |
| 47300 | 10 | 18,000 | ● | | | | | | 12 | 80 | 50 | 125 | 130 |
| 47310 | 10 | 18,000 | | ● | | | | | 12 | 80 | 50 | 125 | 130 |
| 47400 | 10 | 25,000 | ● | | | | | | 12 | 80 | 50 | 125 | 130 |
| 47410 | 10 | 25,000 | | ● | | | | | 12 | 80 | 50 | 125 | 130 |
| 47610 | 10 | 36,000 | | ● | | | | | 13 | 80 | 50 | 125 | 130 |
| 47720 | 11½ | 50,000 | | | ● | | | | 15 | 85 | 50 | 140 | 130 |
| Clevis | | | | | | | | | | | | | |
| 47315 | 10 | 18,000 | | ● | | | | | 12 | 80 | 50 | 125 | 130 |
| 47415 | 10 | 25,000 | | ● | | | | | 12 | 80 | 50 | 125 | 130 |
| 47615 | 10 | 36,000 | | | | ● | | | 13 | 80 | 50 | 125 | 130 |
| 47725 | 11½ | 50,000 | | | | | | ● | 15 | 85 | 50 | 140 | 130 |
| **SMOGTYPE** (Futura Series) Ball-Socket | | | | | | | | | | | | | |
| 47350 | 10 | 18,000 | | ● | | | | | **17** | **100** | **60** | **195** | **180** |
| 47360 | 10 | 18,000 | | | | | ● | | **17** | **100** | **60** | **195** | **180** |
| 47450 | 10 | 25,000 | | ● | | | | | **17** | **100** | **60** | **195** | **180** |
| 47460 | 10 | 25,000 | | | | | ● | | **17** | **100** | **60** | **195** | **180** |
| Clevis | | | | | | | | | | | | | |
| 47365 | 10 | 18,000 | | | | | ● | | **17** | **100** | **60** | **195** | **180** |
| 47465 | 10 | 25,000 | | | | | ● | | **17** | **100** | **60** | **195** | **180** |

Fig. 2

droops. These provide effective protection for the undersides, tending to keep them clean and shielding them from direct impingement of rain. Under average conditions it can be assumed that a clean, dry area will exist under these two petticoats. These two areas of high resistance will be in series with leakage currents.

Petticoat (C) in Figure 1 will be seen to have an extremely deep underside cavity, with a secondary petticoat adding extra surface length in the most protected area. Except for conditions of high humidity, a major portion of the underside area surrounded by petticoat (C) can be considered fully protected against moisture. Even if partly contaminated, the natural dryness of this inner surface will produce considerable leakage resistance. Severe contamination of this inner surface is unlikely. Here exists the major barrier to leakage currents, reinforced by other high-resistance zones in series.

From this explanation it will be seen that greater leakage length is not the sole criterion for evaluating a Smogtype insulator. Longer extensions of the porcelain dielectric provide more and larger underside areas in series. These result in leakage resistance far out of proportion to a few inches of increased surface length.

Another point of design in the Smogtype insulator deserves attention. Wet leakage of highly contaminated units in a vertical string is accentuated by cascading water. In severe cases, such cascading can electrically bridge adjacent units. It will be seen in Figure 1 how varying diameters of the three porcelain shells tend to break up an uncontrolled cascading effect.

For identification of various O-B suspension units, and data related to the general subject of leakage, the attached table has been prepared (Figure 2). For convenience in highlighting Smogtype insulators, their essential differences are listed in bold face type.

Smogtypes have found ideal applications in districts of severe industrial fallout, in areas of high fly-ash concentration, in locations where exceptionally heavy field dust is expected for long periods, and in coastal regions of high salt concentration, to name a few.

In the majority of cases they have provided permanent remedies, or effected long delays in the recurrence of contamination trouble. Compared to the cost of on-the-line cleaning or more frequent change-out, Smogtype insulators will prove to be a highly profitable investment. In exceptional cases where contamination literally runs wild, such as a line close to the lee side of a cement plant, we suggest consultation with O-B engineers who may perhaps suggest a more effective approach.

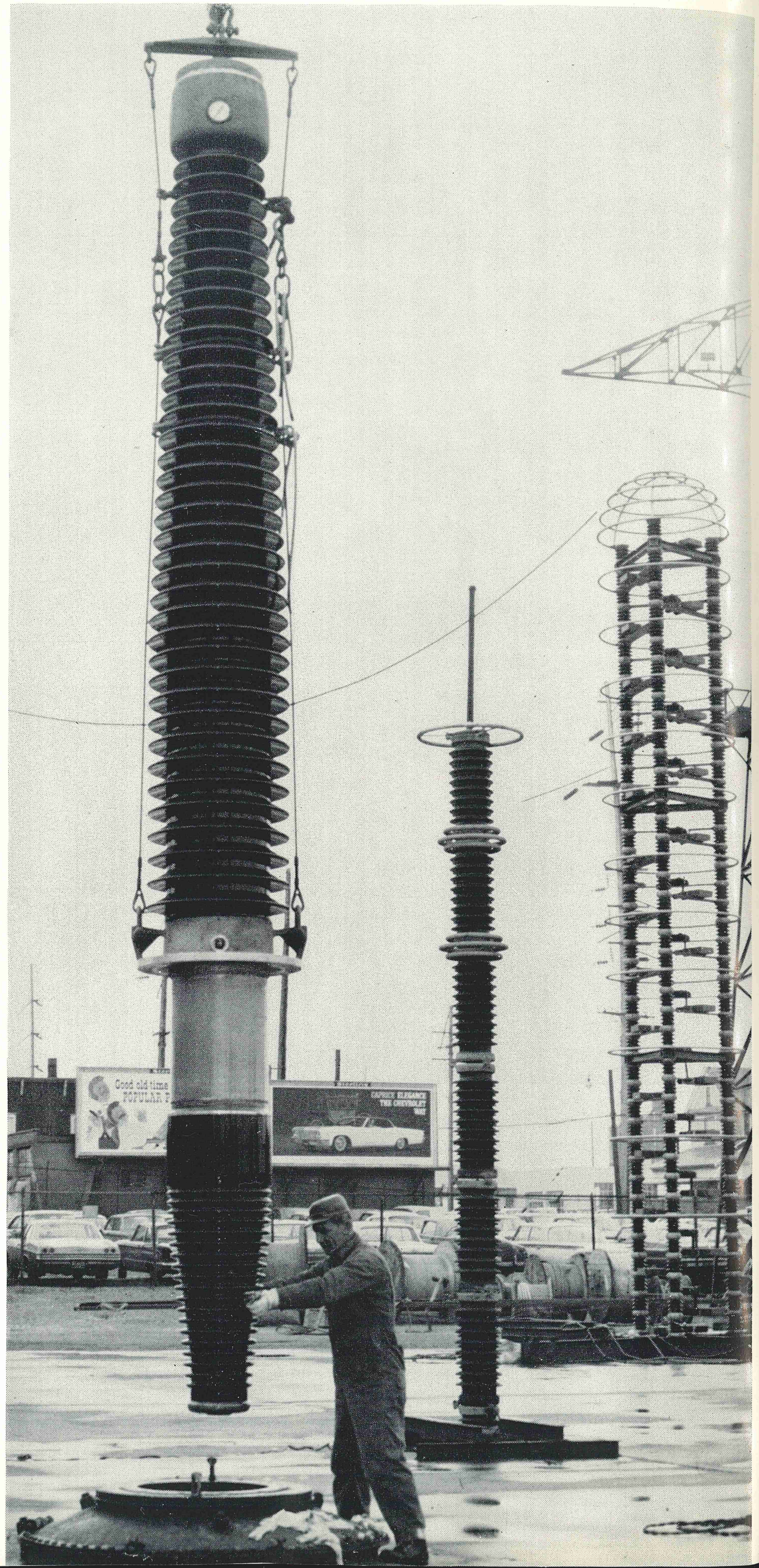
# First 500-kv transformer bushings get full certification test in O-B's High Voltage Laboratory

Four huge, new, 500-kv, GK-75H transformer bushings have successfully passed specified acceptance tests in O-B's High Voltage Laboratory and are on their way to assembly into single-phase EHV transformers being built by one of the large electrical manufacturers for a West Coast utility. The spectacular new bushings have a BIL of 1550 kv and a wet switching-surge withstand strength of 1250 kv. Minimum creep distance is 360 inches, and they are rated at 2,000 amperes.

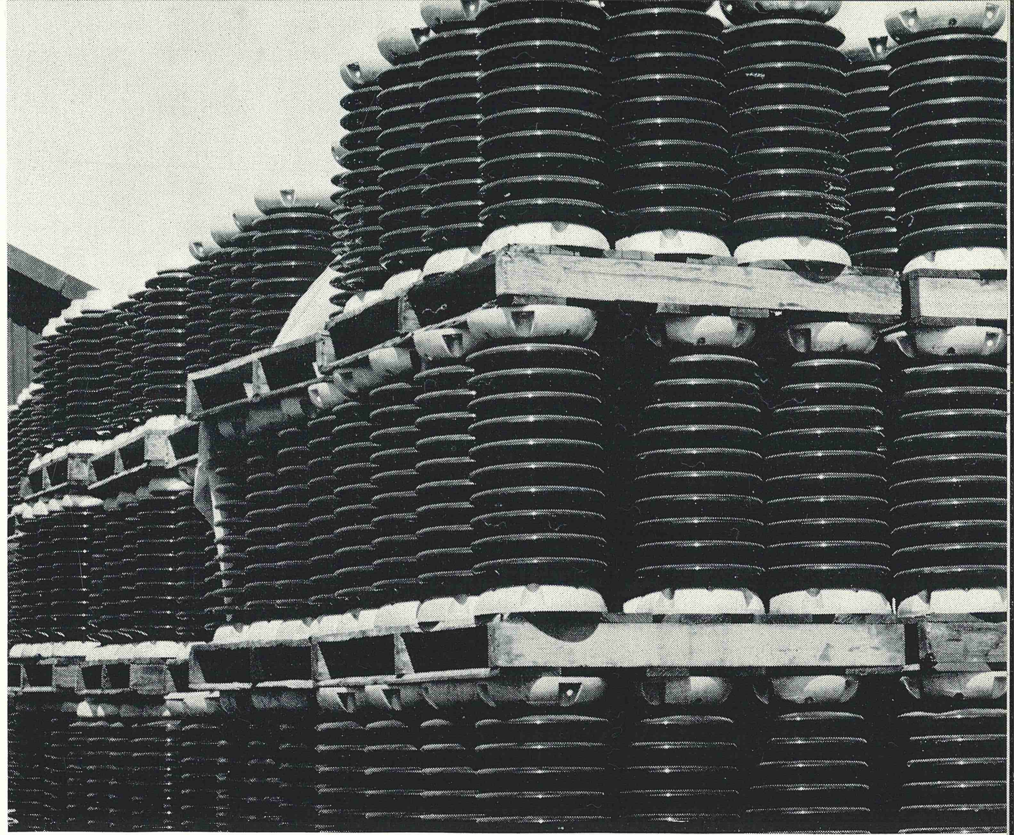
While these bushings are the first Ohio Brass has built specifically for 500-kv service, they are not the factory's first 1550-kv BIL bushings. O-B has had over six years' experience in designing and building EHV bushings, beginning with the 1550-kv BIL bushings furnished for up to 460-kv service on the Pennsylvania Electric Company's test line. During the ensuing period a substantial number of 345-kv bushings of varying BIL's have been built and shipped.

The GK-75H transformer bushing shown in the test yard of the laboratory is approximately 22 feet in over-all length, of which 15½ feet towers above the tank flange. The flange itself is 31 inches in diameter, and the largest of the porcelain skirts is 27 inches in diameter. The net weight of a single bushing is 2½ tons.

500-kv, GK-75H bushing for EHV transformer being lowered into oil tank prior to testing at O-B's High Voltage Laboratory.



# Modern EHV station construction emphasizes adaptability features of O-B's full line of stacking posts



The emerging pattern in EHV station-design practices indicates a definite trend toward stacking-post construction and incorporates an advanced degree of insulator evaluation and specification. Station BIL's are carefully coordinated in preliminary planning stages with the computed protective levels which can be precisely maintained by versatile, competent arrester equipment. Among the multiple objectives being achieved, the principal accomplishment is the substantial cost savings which results from reduction of surplus insulation.

Stacking-post insulators have a favorable combination of inherent qualifications which are particularly well adapted to the specific requirements encountered in EHV station planning. As a result, customer demand for station posts has far outstripped the industry's manufacturing capabilities and, while improvement in deliveries is now in sight, posts continue to have the distinction of being the insulator component requiring the greatest lead time in ordering.

Advantages of posts in EHV station construction can be delineated in the following qualifications:

1. Graduated BIL
2. Cantilever Strength
3. Deflection
4. Graduated Strength
5. Contamination Resistance

Graduated BIL refers to the mechanical flexibility which characterizes the manufacture of symmetrical posts, providing the option by which individual stacking units of practically any desired height and electrical rating can be produced. These units can then be combined into insulator stacks which closely meet predetermined BIL specifications. Insulator stacks required to obtain the BIL's associated with EHV voltages are necessarily high, and under such conditions the cantilever strength and deflection become determining factors. This is particularly true in the relation of post columns used to support air switches, where operating parts are heavy and alignment must be maintained within prescribed limits.

The height of EHV stacks has led to the recent development of tapered stacks, a design arrangement which combines heavy-duty units at the lower end of the stack and lighter-duty units at the upper. Substantial savings in cost are possible through the careful matching of mechanical and electrical strength requirements with the ratings of consecutive individual posts in the assembled stack. The appearance of the tall, tapered stacks is also considered to be an improvement over stacks of uniform diameter. Stacking units used to assemble tapered posts differ from standard specifications principally in the unequal diameters of their upper and lower end caps.

The exposed surfaces of stacking posts facilitate natural washing by rain and simplify cleaning procedures using high-pressure jetting streams for removal of contamination deposits. Post surfaces are well adapted for the application of silicone coatings to combat severe or tenacious accumulations.

Ohio Brass stacking-post insulators are manufactured of the finest-grade electrical porcelain and meet the most exacting standards established by high-voltage applications. The full line of sizes, strengths, ratings, and adapter units facilitates selection and ordering procedures for any normal installation. O-B district managers will be glad to assist in establishing proper specifications for station-post applications.

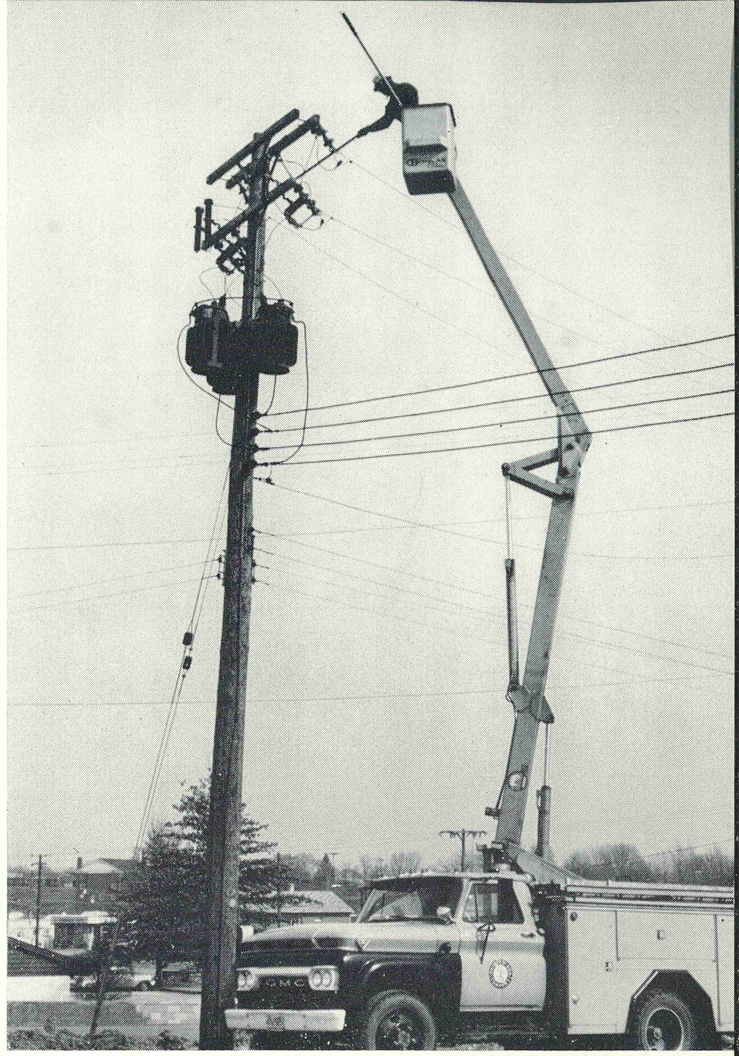
Emergency calls . . .
routine inspections . . .
temporary or
permanent repairs . . .
general service
assignments . . .
line crew assistance . . .

all are part
of a day's work
in the . . .

# Dateline diary of a busy Holan Bronco 83

Maneuverable aerial elbow speeds installation of electrical service at a new residence.

Fast-moving aerial bucket cuts time needed to replace lamps and photocells in city streetlights.



Serviceman in aerial bucket checks for loose connections in pole hardware, using a switch stick.

For MN-517, a Holan Bronco 83 Aerial Elbow, assigned to the Mansfield Line Section of Ohio Edison Company, every work day starts the same way — a normal check-out of crew, equipment, and materials.

Although most work is planned just before the unit leaves the service building, there's no set route or routine.

It has to be this way, because emergencies often arise overnight. The day's work schedule, as well as the required complement of materials and supplies, can be changed considerably by a last-minute call.

The name of the game is trouble shooting. The crew: An Ohio Edison line serviceman assisted by a Class C lineman.

Trouble shooting calls for special qualities in both men and equipment. The Bronco 83 and its crew have many of these special qualities in common. For example, both are long on capability and flexibility. Both can be depended on to do difficult tasks in minimum time with utmost efficiency.

The Bronco 83 supplies the strength and stability with more reach, ruggedness, and reliability on the job.

*Variety* describes the daily duties of the Bronco 83 and its crew: Answering "no light" calls and restoring service. Responding to complaints about flickering lights. Following up on reports on sparking, sputtering, loose connections. Making normal calls to install or remove service drops at residential, commercial, and industrial properties. Assist other crews when called.

The following timetable is typical:

*7:30 A.M. — Check Out Time.* Ohio Edison people know it's important to keep equipment in top shape for top performance. Entire aerial device is thoroughly inspected to assure reliable operation and complete safety for crew members. At the same time, materials on the unit are checked against anticipated jobs — extra materials are taken aboard if needed.

*9:10 A.M. — "Power On".* Electrical service is connected at a new home, in a residential area south of the city. This job, which includes installations of a service drop and electric meter, is completed in about 30 minutes. Although connection without an aerial device could have been made, thanks to MN-517, the work is done more easily.

*9:55 A.M. — "Power Off".* Only a few minutes are required by the crew to cut off electric service to a house doomed for demolition in an Urban Renewal area.

*10:05 A.M. — Lights Come On Again.* Aerial Elbow places the line serviceman at streetlight level in less time than it takes to tell. Carrying a new lamp and a new photocell unit, serviceman checks existing installation and replaces lamp or cell as needed. (A hat placed over the photocell simulates nightfall while the lamp is checked out.) Time at the top of the pole—no more than 10 minutes.

*10:25 A.M. — Outage Averted.* Maneuverability and stability, far reach and fast action of the aerial device make it possible to follow up fast on a customer report of fire at the top of a pole carrying a 12-kv distribution line. The lineman is immediately moved to line level — 41 feet up — where visual inspection reveals a loose hot line clamp. Such conditions are frequently brought to light by customer calls reporting fire or television interference.

Working quickly with a "grip-all" stick, the lineman tightens the clamp, not noticeably damaged by arcing, and checks the condition of other clamps and fuses. Service is not interrupted. In similar cases, however, where the clamp is burned, power must be cut off temporarily while damaged parts are replaced.

Using the aerial device, the serviceman is in the air only one hour and 15 minutes. Had the lineman worked from the pole, a longer "grip-all" stick would have been required and the job would have taken considerably more time. Visual inspection also would have been more difficult for a pole-working lineman.

*11:20 A.M. — Call For Help.* Line service crew is asked to assist another crew in a transformer installation. This call, answered en route to the service building for lunch break, was more to supply auxiliary manpower than to pro-

*(Continued on next page)*

OHIO BRASS MANAGEMENT REPORT

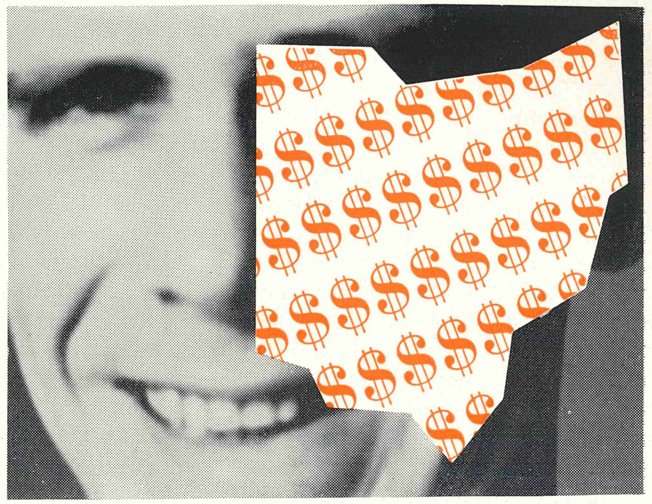
# "Profit" is a happy word in Ohio and at Ohio Brass

**BY ROGER A. BLACK**
PRESIDENT, THE OHIO BRASS COMPANY

The Governor of Ohio has forcefully informed the business world that "profit is not a dirty word in Ohio." Neither, we hastily would add, is "profit a dirty word at Ohio Brass," although we sometimes wish it came through a little louder. We are now preparing our financial report for 1966 and note that we have to go back through many lean years to find a year to approach the 1966 profit level.

**WE ARE REMINDED** of the key role of profit in economic growth by an article in the Jan.-Feb. issue of HARVARD BUSINESS REVIEW by John J. Scanlon, vice president and treasurer, American Telephone and Telegraph Company. His theme is that despite our country's prosperity, the economy is not growing fast enough to maintain full employment.

**TO SUPPLY JOBS FOR 14 MILLION** additional people coming into the work force during the next decade, Mr. Scanlon points out, will require that jobs must increase 50 per cent faster than the present rate. We have to accelerate spending on plant and equipment to provide the jobs. And plant and equipment



spending will proceed only where there are reasonable profit opportunities. Internal funds generated by reinvested earnings and depreciation charges provided three-fourths of the investment total in plant and equipment between 1946 and 1965. So profit remains the key to growth as it always has been, in the free enterprise system.

**AS YOU EVALUATE OHIO BRASS** as a supplier, we hope you note that we now have the profit capability, based on 1966 performance, to continue to grow as your needs grow. We are ready, and capable, of expanding our facilities. We are completing a heavy investment in insulator-manufacturing equipment for the Newell plant, scheduled for production by midyear. For us, "profit" is a happy word and, we hope, for our customers and our industry. 761-H

THE OHIO BRASS COMPANY • MANSFIELD, OHIO • 44902
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario, Canada

OHIO BRASS

6705-H

# Hi-Tension News

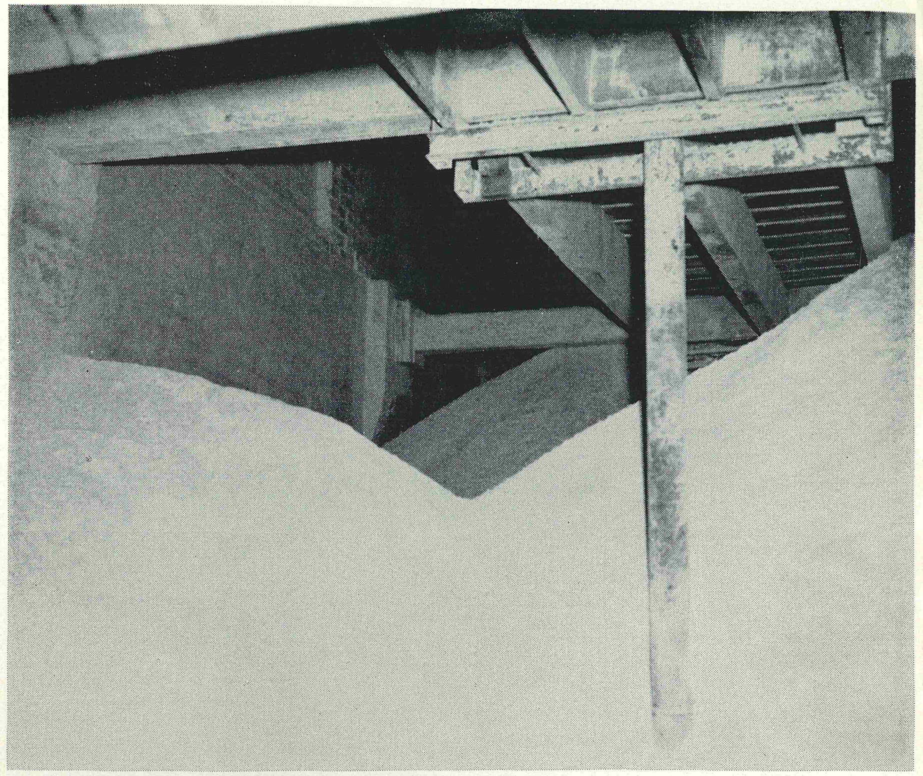
MAY 1967

# Newell is NOW ! ! !

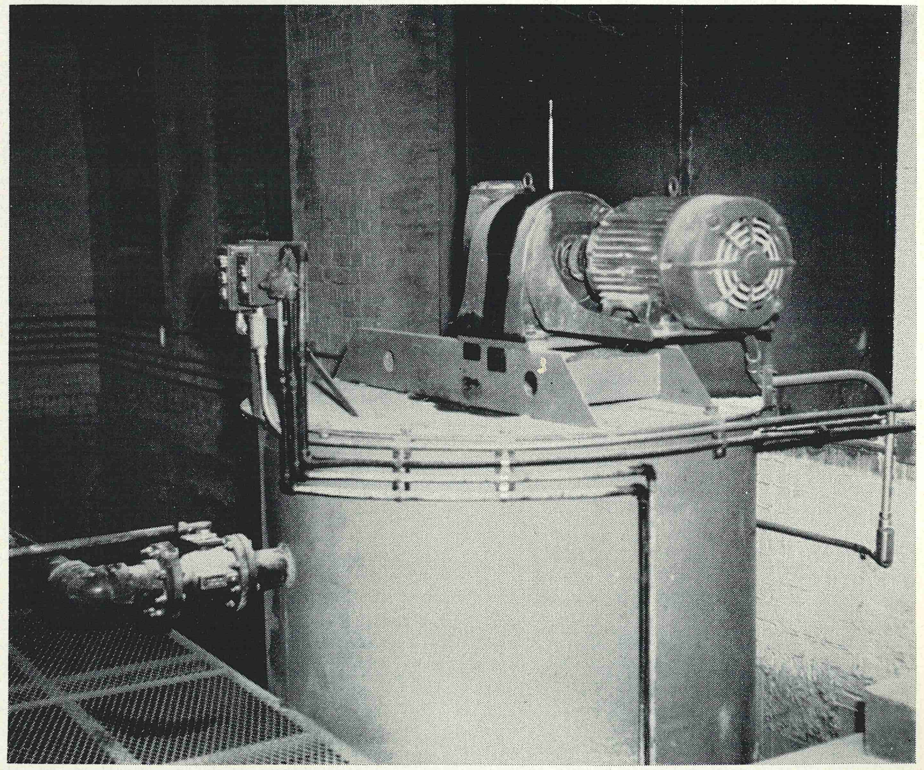
What is Ohio Brass doing to increase porcelain production and alleviate delivery problems?

**O-B Newell.**

The accompanying photographs show the progress made at the O-B's newest porcelain manufacturing facility in Newell, West Virginia. Leased in April, 1966, O-B's new plant will manufacture line and station posts.



Clay materials arriving from clay pits are received in Newell in bins like these which hold one to eight carloads.

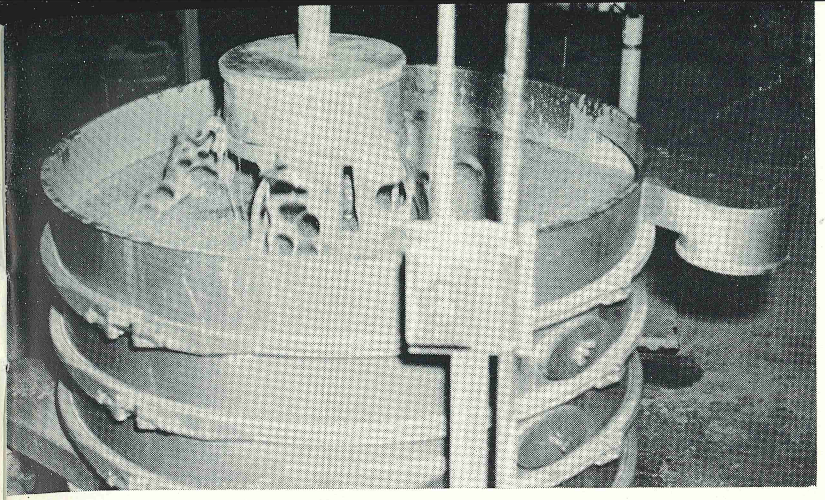


This is the O-B Newell mixing vat in operation. Space, you will note, has already been made available for future equipment additions.

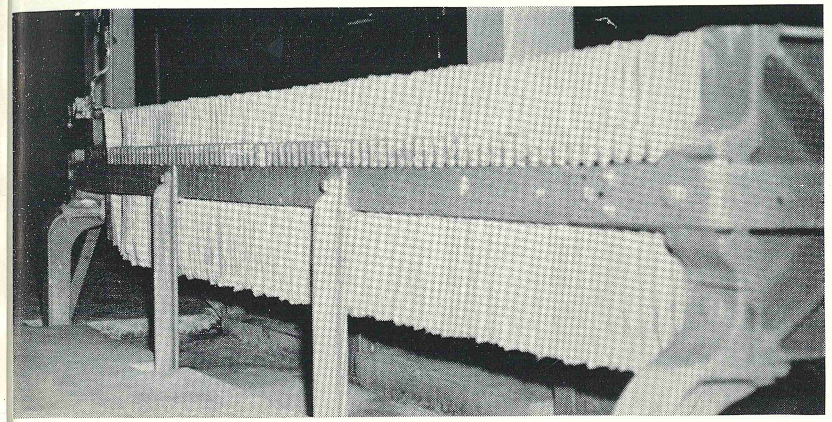
Hi-Tension News
MAY 1967, Vol. 36, No. 5

**ON THE COVER** — Welder at work! An anchor for a production machine is installed at O-B Newell. In this month's feature story O-B illustrates the significant developments at Ohio Brass Newell which are bringing the new plant rapidly into production capacity.

**THE OHIO BRASS COMPANY**
**Mansfield, Ohio 44902**

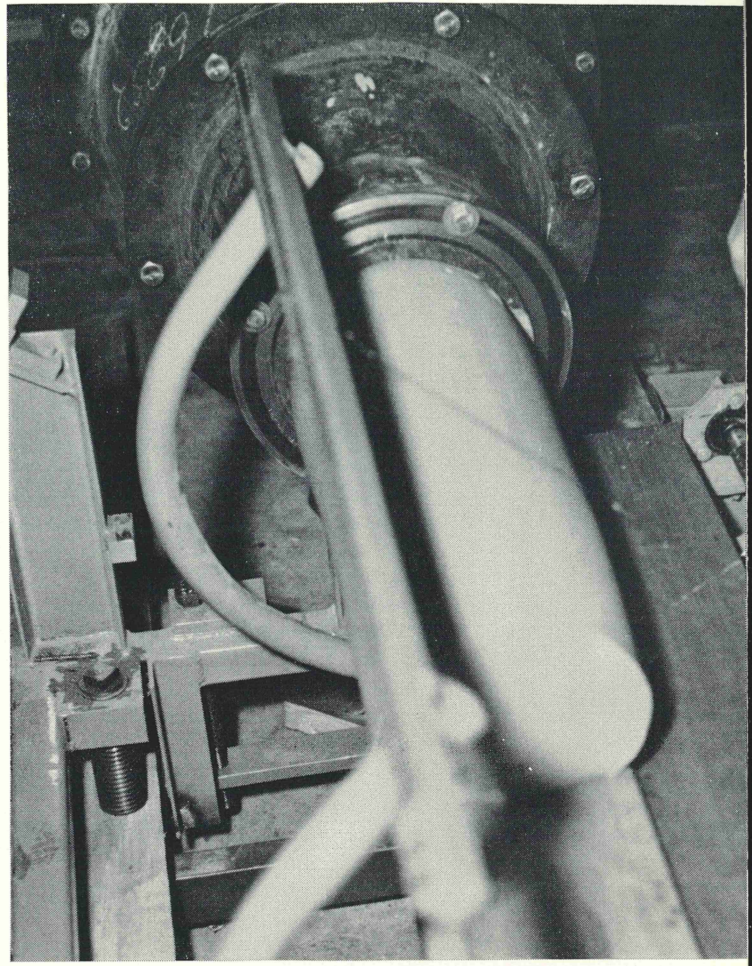


From the mixer, the water-suspended mixture flows through this gyrating screen where it is shaken violently to remove remaining foreign particles.



As O-B Newell's production schedule requires, the liquid clay mixture is piped from storage into pressure tanks and forced under pressure into filter presses. "Pumping the presses" forces the water out of the clay by liquid pressure. Water runs out of the mixture and the clay "residue" remains in hundreds of square chambers.

Clay filter cakes weigh approximately 38 pounds. Each cake is a dense mass of clay, shaped into a giant molded square.



From the filter press the clay cakes move to the "pug-mill" where moisture is redistributed and de-airing of the clay occurs. The O-B Newell pug-mill extrudes a cylindrical mass of clay. Its size depends on the desired finished product.

Making rapid strides to achieve early post production capacity, O-B Newell represents The Ohio Brass Company's ever continuing efforts to provide sufficient post products to meet the electric industry's growing needs.

# Specification of EHV insulated conductor supports greatly simplified . . .

For this conventional twin-conductor V-string insulated suspension assembly, 13 items of hardware fittings are required. Some of these pieces are especially designed to provide the swiveling range necessary in V-string construction. It would take an engineer with intimate knowledge of the assembly's design principles to select and specify the correct fittings. Perhaps the reader may be one of those engineers who has sweat out such a process.

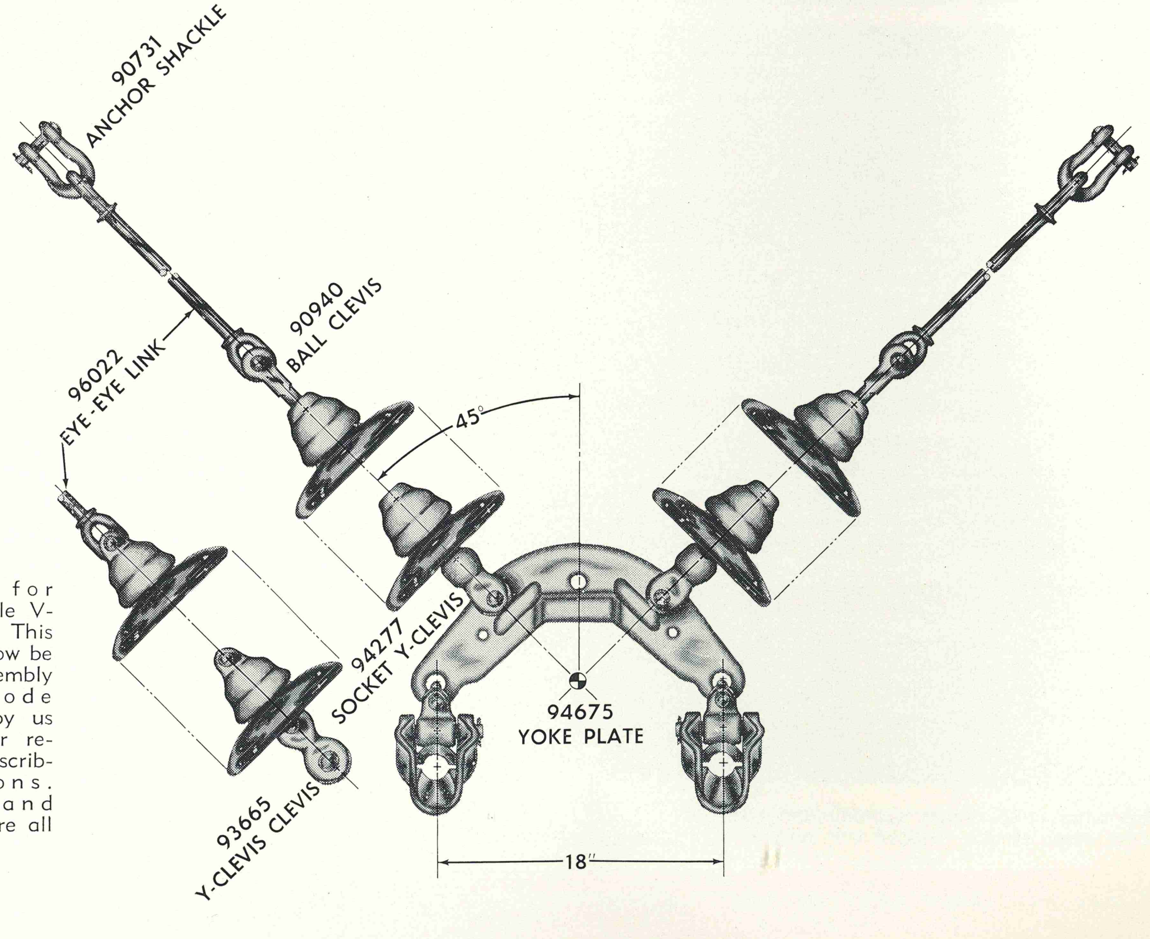
Now, for the more commonly used supports, the whole combination can be described by an assembly number, plus a code number . . . a number that applies to your project only, once your requirements are known. The assembly number denotes the general configuration. The code number is assigned by us to cover your particular options: ball-socket or clevis insulators, size of conductor, and specification of extension links. This code number, which usually becomes yours because no two combinations are quite alike, is combined with the assembly number to use in ordering and in any other description. It covers the complete device.

On several recent EHV jobs we have found this practice capable of saving almost endless conferences, letters, and telephone calls. It also minimizes chances of mistakes. Men who have done it both ways shout its praise.

In the past, when pieces were considered separately, it was common to run into cases where parts would not interconnect. Among the literally thousands of O-B miscellaneous fittings, it is perfectly natural that some of these come in more than one size. It sometimes happened that someone would wind up with a clevis containing a ⅝-inch pin to fit a tongue with a 9/16-inch hole. Now, the factory is guided by the assembly specification and picks out parts that someone has previously put together and tried.

This method of specification and ordering may be new to you. With closer acquaintance, we feel you will like it. To make such an acquaintance, talk it over with your O-B district manager.

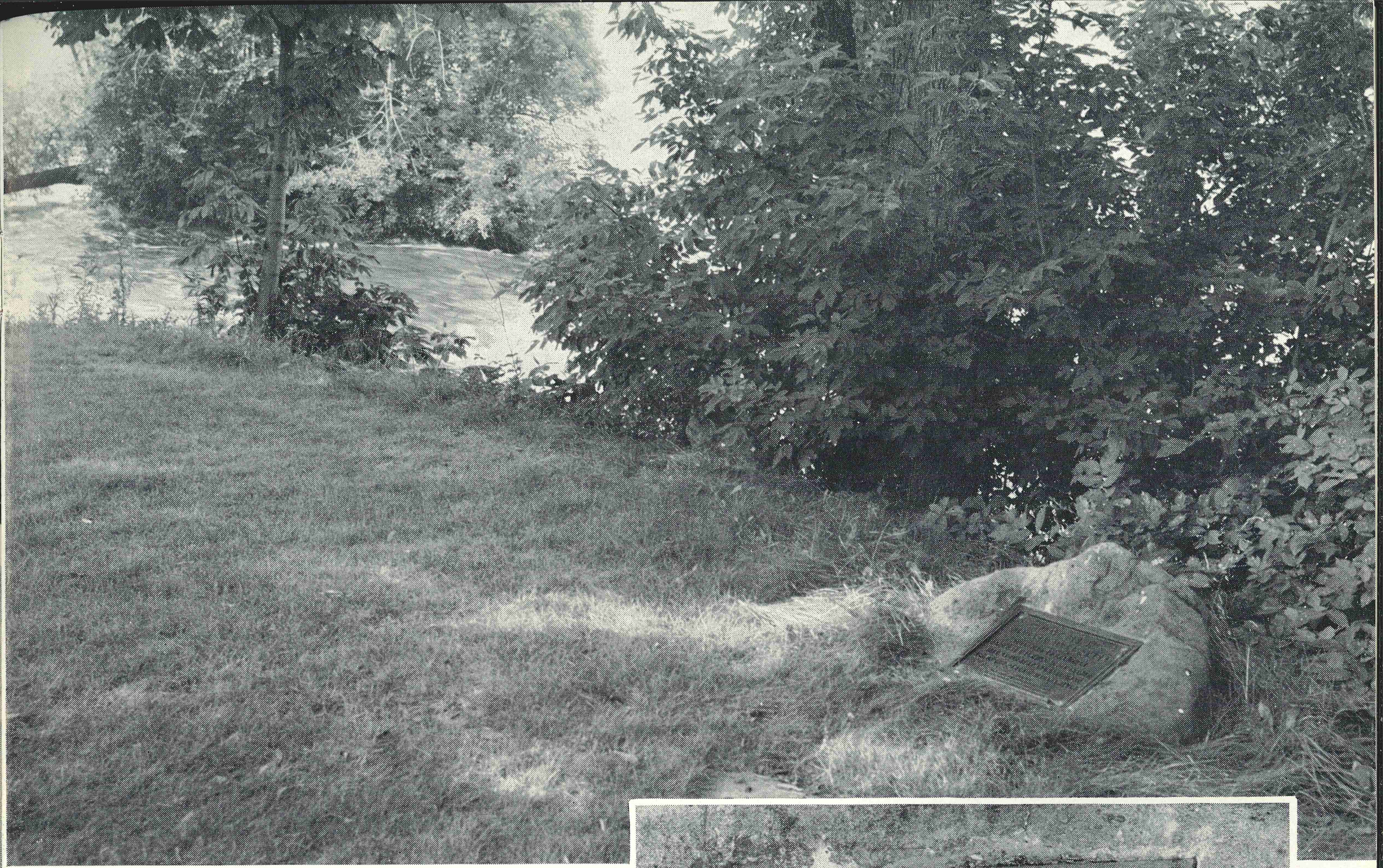
Naturally, this new method of dealing with assemblies does not substitute for special treatment when required. If design of a line calls for new approaches to the hardware question, we are fully prepared to embark on any development project needed. Our extensive experience in supplying insulated supports for the majority of operating EHV lines, and the wide selection of equipment available, part of which may be utilized, will probably provide some welcome shortcuts even in the most difficult cases.



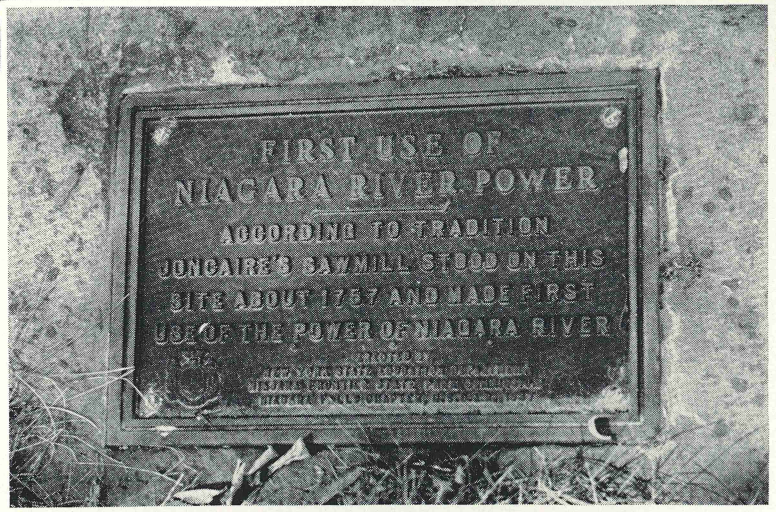

Typical assembly for twin-conductor single V-string construction. This entire device can now be specified by an assembly number, plus a code number assigned by us after knowing your requirements, and describing various options. Time, confusion, and possible mistakes are all greatly reduced.

ASSEMBLY NUMBER 95142





Inconspicuous, and far off the beaten path of tourists at Niagara Falls, New York, is this small marker commemorating the first use of the power of Niagara River 210 years ago.




# Milestone in the use of power all but forgotten

"The first" of things, when it attains worldwide recognition, is often marked by some imposing monument . . . but not always!

For instance, some day simply take a stroll at Niagara Falls, New York. Walk along the river bank above the American Falls . . . a place not one tourist in a million must ever go. Part of the way there is a tiny gravel path. The rest of the way, nothing. No signs. No arrows. No notations in a guide book. Just a plain river bank.

Keep your eyes sharp. Partly hidden by shrubbery, and only a few inches above the uncut grass, you will discover a boulder into which is set a small bronze plaque reading:

FIRST USE OF
NIAGARA RIVER POWER
ACCORDING TO TRADITION,
JONCAIRE'S SAWMILL
STOOD ON THIS SITE
ABOUT 1757 AND MADE
FIRST USE OF THE POWER
OF NIAGARA RIVER

Today, when we see the huge Sir Adam Beck Plants on the Canadian side and the Power Authority of State of New York project on the American side, we are mightily impressed with the fact that few things have grown to such proportions as Joncaire's little sawmill.

This next-to-forgotten rock with its modest plaque might be compared to Mecca for those of us in the electric power industry.

# Wherever the big EHV systems are being planned or built . . . you'll find O-B Dynagap Arresters

Ohio Brass Dynagap station-class lightning arresters have been specified for overvoltage surge protection on a majority of the EHV systems (345 kv or over) being planned or constructed on the North American continent, as well as for many EHV systems in foreign countries.

O-B has established an outstanding record for pioneering the development of the high-performance protective equipment essential to modern EHV system design. Arrester improvements have expanded the powerful controls of the current-limiting Dynagap to achieve a remarkable versatility in meeting severe operating requirements. Superior operating characteristics obtained through application of the Dynagap principle are the major factors by which safety margins, fully compatible with drastically reduced insulation levels, can be maintained. These advances in arrester performance have had great economic significance in all recent EHV system planning, since they are directly responsible for saving thousands of dollars in the cost of equipment insulation.

Ohio Brass Dynagap arresters are installed on the highest-voltage transmission line in the western hemisphere, the 735-kv Hydro-Quebec system which spans the Province of Quebec to bring power from far northern hydro facilities to the metropolitan areas of Montreal and Quebec. C-O-B arresters with ratings of 636 kv (for transformers) and 678 kv (for reactors) have been installed at Hydro-Quebec's Manic, Boucherville, Laurentide, and Levis stations. The tall, 636-kv Dynagap arresters shown in Figure 1 are designed to protect a transformer BIL of 2050 kv. An insulation coordination diagram representative of these values is shown in Figure 3.

The 420-kv arrester is the rating normally selected for 500-kv systems, although some 396-, 444-, and 460-kv arresters have been installed to meet special dynamic conditions. The 420-kv arresters are generally used to protect a 1425-kv basic insulation level, as indicated in the diagram of Figure 4.

Greatest variation in EHV arrester ratings is found in the specifications for 345-kv systems. Lowest ratings installed are the 258-kv Dynagap arresters used to maintain BIL's as low as 900 kv in closely coordinated systems, while the more common ratings of 300 and 312 kv protect systems with BIL's as high as 1175 and 1300 kv. A typical 1175-kv BIL coordination diagram is illustrated in Figure 5.

The range in arrester ratings and system BIL's at 345 kv can be explained by recalling that many of these systems were either in the planning or construction stages at the very time the most rapid development work was being accomplished on EHV arresters. Dynagap arresters introduced as recently as 1957 were the first to provide a precisely predictable straightline sparkover response, the major arrester characteristic involved in permitting drastic reductions in system insulation levels.

Of some general interest is the fact that former maps showing arrester installations were strongly influenced by the incidence of lightning in various sections of the country. In EHV systems this distinction has ceased to exist, since the switching surges generated by the systems themselves have become the predominant overvoltage transients for which arrester protection must be provided.

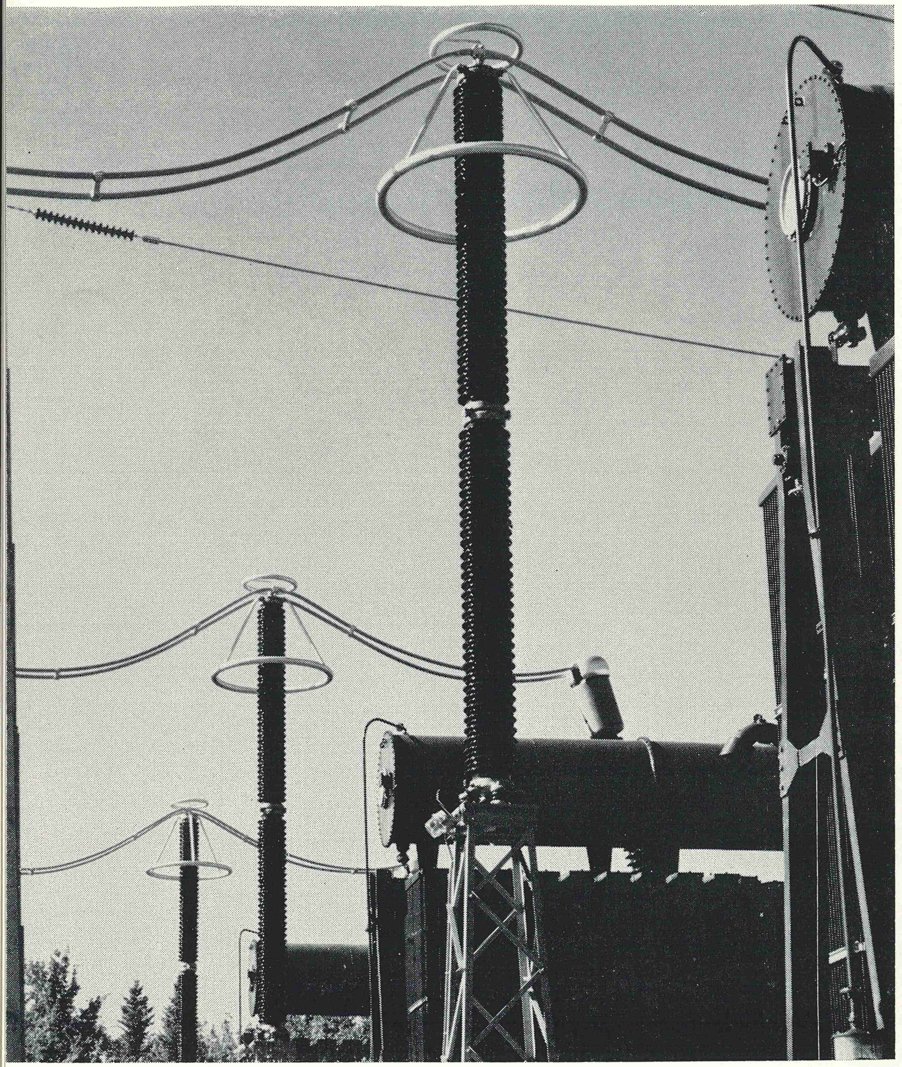


Figure 1 — Dynagap 636-kv arresters installed at Levis Station on Hydro-Quebec 735-kv system.

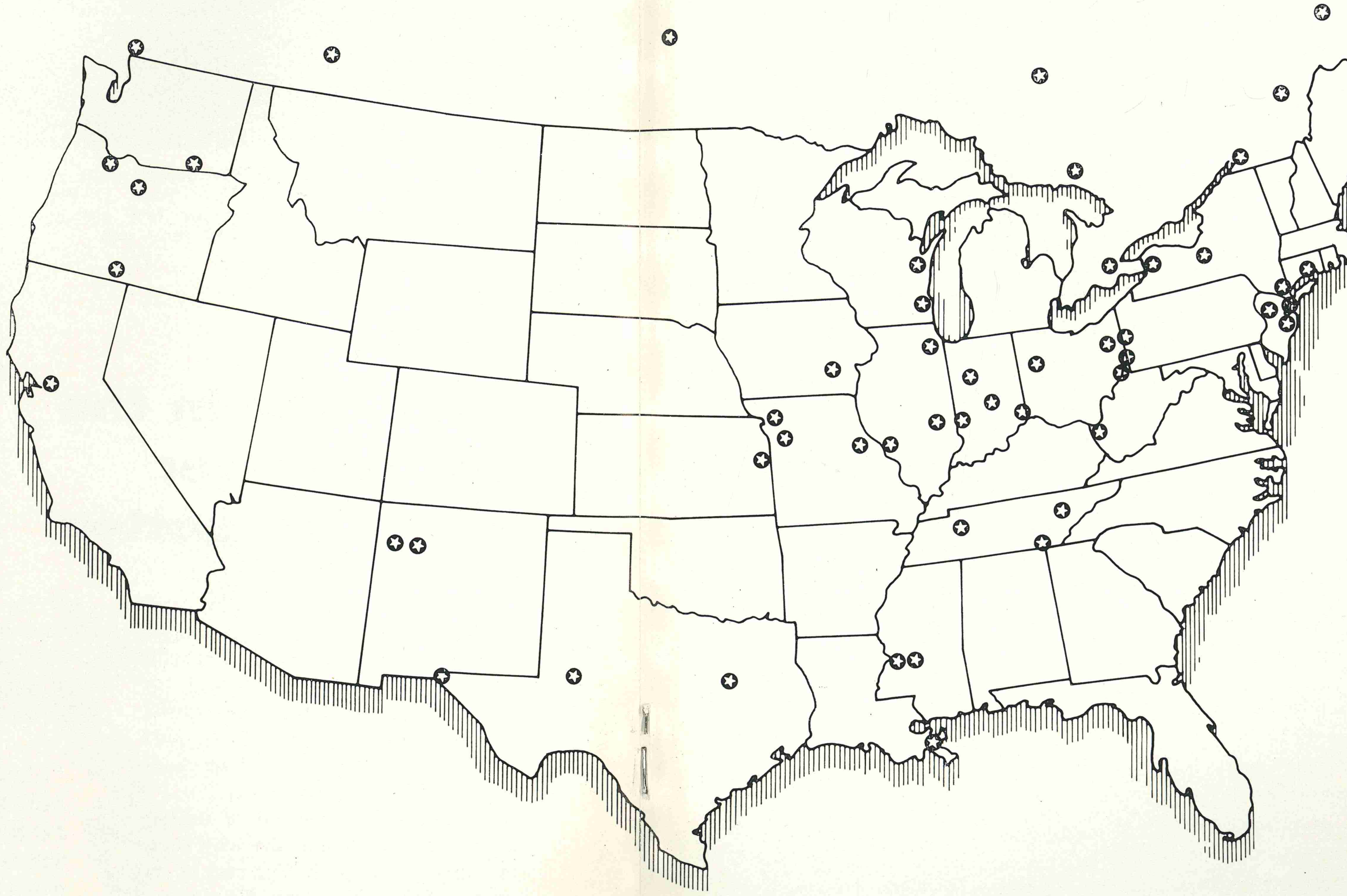


Figure 2 — Locations of Ohio Brass EHV lightning arresters.

**Insulation coordination diagrams**

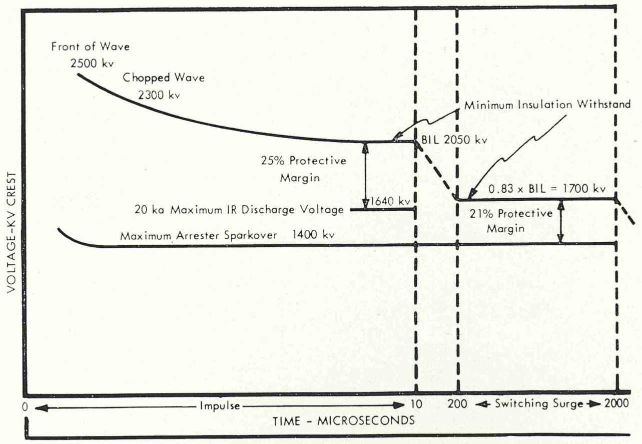



Figure 3 — 636-kv arrester on 735-kv system.

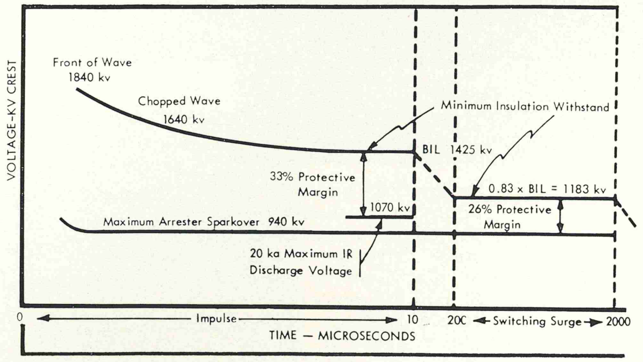



Figure 4 — 420-kv arrester on 500-kv system.

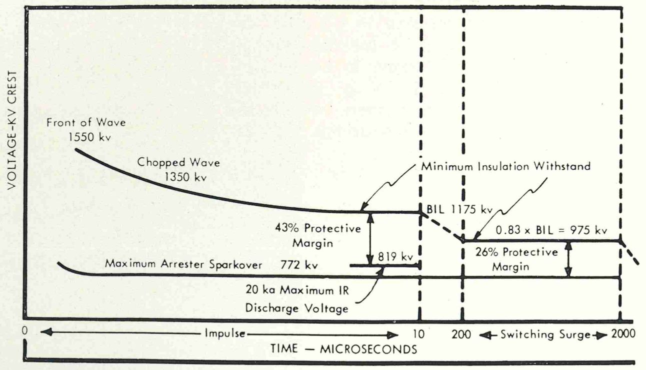
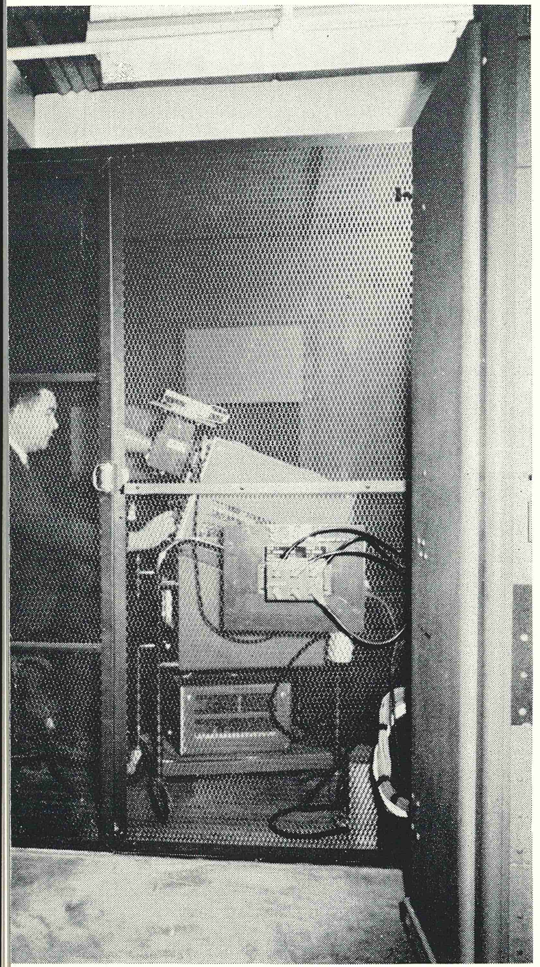



Figure 5 — 312-kv arrester on 345-kv system.

# Laboratory "clean rooms" keep the bugs out of oscilloscope recordings



Design research for lightning arresters is conducted on a special impulse generator capable of discharges in excess of 100,000 amperes. Accurate readings of tests are a common requirement in development work and call for elimination of all stray interference in oscilloscopic measurements. The 'scope is totally housed in a grounded metal screen enclosure to block spurious signals.

Not all oscillographic measurements in a laboratory are precision operations . . . for many tests all that is needed is a gross indication. But there are other times when we want to "quarter-saw" hairs. Very few laboratories enjoy the hair-splitting facilities we commonly provide at Ohio Brass.

On four of the impulse generators used in technical determinations the 'scopes are housed in "electrically sterile" cages. The instruments are surrounded with grounded metal netting to exclude all stray interference. This complete shielding eliminates false signals. A pip on the screen relates to the test, and doesn't have to be sorted out later.

Care such as this is routine in the O-B High Voltage Laboratory. Many times, engineers of our power company customers have commented on the clean sweeps and overall purity of our oscillograms. Actually, it is a matter of convenience. People have better things to do than spend time eliminating the hash in a group of test recordings.

One of our clean rooms is especially interesting. This houses the scope used on the 3,000-kv research generator. Because this generator is unique in its ability to produce ultra-steep-wave discharges, and has great flexibility in many other directions, accurate readings often demand exceptionally good technique.

A platform was first built on post insulators to get complete isolation from the concrete laboratory floor. The surface of this platform was then covered with a continuous heavy copper sheet. Framework for the walls and ceiling consists of two by fours to which copper screening is attached, both inside and out. All seams are soldered, and both layers of screen are bonded together. The door, built the same way, makes numerous solid contacts when closed. Thus the room is double-shielded.

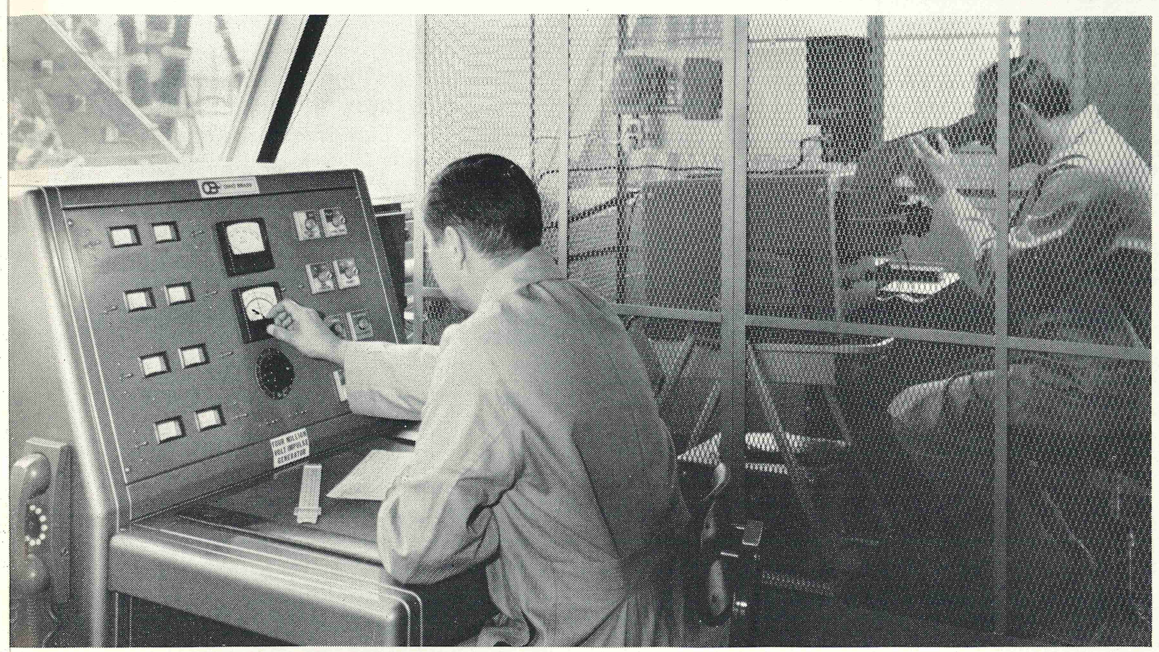
But, interference can easily travel on various service wires. The intercom, for example, can introduce its own variety of "hash." It is impossible to get 100 per cent shielding on control leads to the oscilloscope. The 115-volt power supply for the instrument and lighting can feed in spurious signals from a host of sources.

So, one at a time, we eliminated these troubles. The intercom stays outside the screening. It works just as well there and can't introduce stray signals. The tripping circuit and other scope controls terminate on the outside in a light box and transmit their energy in the form of light beams that shine through the screening and are picked up on internally mounted photo cells, where signals are amplified for use. To get clean 115 volts, a generator is mounted in the room and driven by an external motor through a long insulated shaft.

All that enters this room is a single triple-shielded test lead that keeps extraneous signals to an absolute minimum. For many investigations, the total of these precautions is not needed and, in such cases, there are provisions for more conventional connections. This piece of equipment can produce oscillograms of exceptional quality.

From this discussion it is apparent that operating a major laboratory is not just a question of firing big flashes through the air. There are endless little things that make the big ones meaningful.

For quality control, inspection, and other long product testing runs, a special impulse generator is assigned to this work to relieve larger equipment used primarily in research. From time to time precise data is required from this department, especially in analysis of factory production, and for this purpose the oscilloscope is carefully shielded in its clean room, shown in the background.



Transmission line prototypes are extensively investigated on O-B's new 4,000-kv outdoor weatherproof impulse generator. Accurate test readings are a prime requirement in this class of work. High energy impulse generators are capable of supplying large ground currents following a flashover. This will produce ground voltages which can cause oscillograph interference if a shielded screen room is not used.

Great flexibility of the 3,000-kv research impulse generator often calls for unusually fine technique in the production of pure test data. This elaborately shielded room can operate without the entrance of a single wire, except for the triple-shielded test lead. Instrument synchronizing signals travel on light beams, and service power can be generated within the room.

# Tailor a Bronco 85 to your system

## Two model heights, standard or heavy-duty ratings, two mounting choices, and a wide range of options give you a free hand to match your maintenance needs

In the Bronco 85, Holan offers you just the right reach, strength, and operating flexibility you need to adapt an elbow to your system's working requirements. As a result, a properly equipped Bronco 85 will handle your men and material on the vast majority of your jobs.

Let's start with the standard unit — the 85-40. It offers a working height of 45 feet and a bare-shaft lifting capacity of 800 pounds flat-out. Raise the upper arm to 75 degrees and the bare-shaft capacity increases to 2100 pounds. Add the heavy-duty chassis to the 85-40 and you boost the bare-shaft capacities to 1050 pounds flat-out and 2650 pounds at 75 degrees.

Move up to the Model 85-45 Bronco 85 and you gain a working height of 50 feet. The standard unit offers a 750-pound flat-out lifting capacity and 2000 pounds with the upper arm in the 75-degree position. Flat-out and 75-degree lift capacities increase to 950 pounds and 2350 pounds, respectively, when you install the 85-45 on a heavy-duty chassis.

Any of the Bronco 85 models may be mounted center back of cab (CBOC) or center over rear axle (CORA) to meet your particular preference. Payload ratings remain the same for each model with either mounting configuration. And, all models offer the 270-degree upper- and 100-degree lower-arm actuation range that furnishes the maneuverability your crews need to work under, over, and around your system's underbuild. Completely enclosed actuation cylinders make it easy to reach nearly any position where maintenance is required.

Holan builds strength into each Bronco 85 from the base up. A rigid, skin-stressed base frame resists possible twisting and racking and is held straight, stable, and level by two or four wide-stance "fold-over" outrigger jacks. Further stability results from the 24-inch, reverse-offset pedestal, which mounts many of the rotation-system components down inside the pedestal for a low center of gravity.

What else is standard on Holan's Bronco 85? Consider the Mono-Race turntable which provides 370-degree rotation in either direction. Uniform-stress design of upper and lower arms assures even load distribution for maximum personnel safety and lift capacity. One bucket with mechanical parallelogram leveling is standard too.

Options abound for the Bronco 85-40 and 85-45, standard of heavy-duty models. Add the transformer-handling device with hydraulic winch, or a pivot boom for convenient material handling. Specify bucket swivels, or a second bucket to get two men on the job. Or, select the remote engine start-stop, audible-signal circuit, emergency power system, brake locks, safety interlocks, current-sensing system, an 8,000-pound first-wrap lower arm winch, or even the full Live Line Barehand Method package.

Get a firsthand account of the quality workmanship that goes into a Bronco 85 elbow and the rigid test procedures it must pass before shipment from your Holan representative. He'll be glad to answer any questions and furnish quotation information with just a call. Or, write for additional information to: Holan, Division of The Ohio Brass Company, 4100 W. 150th Street, Cleveland, Ohio 44135.

Holan offers four variations of the Bronco 85 with a complete range of options to give your crews the flexibility they need to work under, over, and around obstacles — plus handle material loads to 2650 pounds.

# More on O-B's 50-year-old plastic insulator

## Here are two Dirigo assemblies to speed installation of industrial or commercial service drops and deadends

Several requests for additional information on the Dirigo plastic insulator resulted from our introductory article published in January, 1967. So, here's a brief introduction to two specific assemblies that employ the Dirigo unit — Numbers 22810-2000 and 52536-3001 feeder-strain clamps.

Each of the assemblies consists of a clevis installed on the 5/8-inch stud of the basic Dirigo spool, a 5/8-inch stud in the spool's boss, and a four-bolt strain clamp mounted on the stud. Minimum breaking strength of the Dirigo insulator unit used in both assemblies measures 10,000 pounds. Each insulator is subjected to a 16,000-volt 60-cycle proof test to insure its insulation integrity before assembly and shipment.

Standard mounting on both the 22810-2000 and 52536-3001 is a 3/4-inch-wide clevis installed on the 5/8-inch stud molded into the insulator body. This clevis mounts easily to an eyebolt attached to the pole. Or, if you wish to employ a clevis strap, an eye may be installed on the stud in place of the clevis — though this combination is not at present cataloged. Either mounting arrangement produces a strong joint beween your pole and the Dirigo clamp assembly that will serve for years without maintenance.

Looking at the clamps on the two units, we see the specific differences in the two assemblies. Number 22810-2000 mounts a straight strain clamp with a 5/8-inch boss installed in the Dirigo spool. Inner clamp surfaces are designed to cradle a bare conductor gently, yet produce sufficient grip to prevent slipping. A bronze keeper is employed to break up the magnetic flux path, designed also to distribute clamping pressure evenly and minimize any chance of conductor distortion over the clamped area. Bolts employed to secure the clamp, conductor, and keeper are straight square-head 3/8-inch bolts with hexagonal nuts.

Assembly Number 52536-3001 feeder-strain clamp uses basically the same clamp, but with one important plus. A stringing eye is cast on to the clamp body to facilitate taking up the span strain during installation and maintenance. This stringing eye is designed along the same lines as those on O-B Strateline clamps which have seen years of service at all distribution voltages. A bronze keeperpiece with four straight bolts is also employed on the clamp with assembly Number 52536-3001.

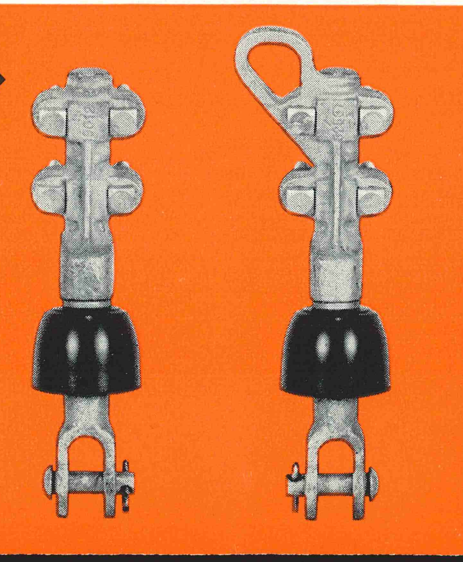
Now, how can you use Numbers 22810-2001 and 52536-3001 on your system? Let's start with service drops to industrial plants or shopping centers. Both units mount easily on an eyebolt installed in the pole. Your drop from the phase line is carried through the clamp from the inside edge. As it comes out the front edge of the clamp, it is formed for a straight shot to the service entrance. Installation is fast, and your men carry one complete unit up the pole with them.

For deadend use, either of the two assemblies may be used to catch off the span strain and help form a jumper loop to the adjacent side of the deadend or corner position. With their built-in high strength, the Dirigo assemblies easily support distribution tensions in deadend, corner, or long spans in all types of environments.

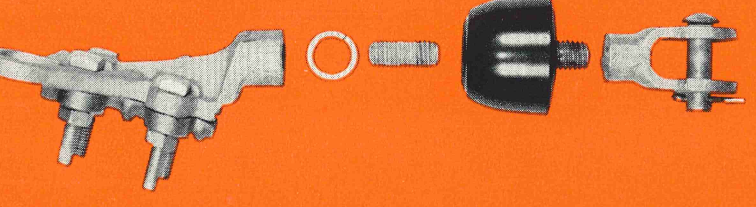
Hot-dip galvanizing of all malleable iron components adds long life to the many service-proved benefits of both Dirigo feeder-strain clamp assemblies. Because the basic Dirigo unit was designed and formulated for outdoor service, it too weather well in all types of conditions. And both the 52536-3001 and 22810-2000 assemblies offer a slim silhouette for aesthetic acceptance.

Find out the many applications of O-B Dirigo insulator assemblies and the many utilities who now use them by asking your O-B district manager. Or, write for additional information to: Plastic Insulator, Ohio Brass Company, 380 North Main Street, Mansfield, Ohio 44902.

Here are two O-B Dirigo plastic insulator assemblies — Numbers 22810-2000 and 52536-3001 feeder-strain clamps — that easily form a compact industrial or commercial service drop. ▶



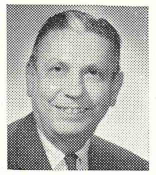
Each of the two feeder-strain clamp assemblies consists of a clamp, lockwasher, 5/8-inch stud, Dirigo insulator body, and a clevis. Mounting requires only an eyebolt through the pole or a strap-bolt combination installed on the pole. ▼



OHIO BRASS MANAGEMENT REPORT

# Dynagap 5 shows free enterprise still works

**BY ROGER A. BLACK**
PRESIDENT, OHIO BRASS COMPANY



It may come as a surprise as you contemplate the myriad rules and regulations and complex tax structure which confront business today. But the spark of free enterprise still burns and every now and then it bursts into flame. Naturally, Ohio Brass comes up as the hero in the example selected. But if your company uses Ohio Brass lightning arresters, the example has considerable self-interest for you, also, and for your customers.

**SIXTEEN YEARS AGO** O-B decided to develop lightning arresters as a principal product line. It was a typical free enterprise decision. We saw an opportunity to offer an improved product and accepted the risks of putting it on the market. In the years that followed, other arrester improvements came fast as O-B and its competitors tried to outdo each other. Free enterprise was at work. Each improvement stimulated further improvement. Everyone—utility, utility customer, manufacturer—benefited.

**ONE OF THE GREAT INNOVATIONS**—even the competition will tell you this—came in 1957 with the announcement of O-B Dynagap. Severe duty once imposed on valve blocks was now handled by Dynagap. System planners working with transformer manufacturers could lower the basic insulation level. The significance went far beyond the dollar savings which were considerable. It accelerated the push to 500 and 765-kv, because transformers for those voltages were no larger than those had formerly been for 345 kv. In fact, it might be impossible to transport a 765-kv transformer if we had to use old basic insulation levels. So again we all benefit as free enterprise helps lower costs and speed technological advance.

**A FEW DAYS AGO,** O-B introduced the Dynagap 5 Thorex station arrester. Its characteristics were developed for safe handling of increasingly severe switching surges on EHV lines. But the durability and other superior characteristics of Dynagap 5 are also available at lower voltages.

**YOU CAN PROBABLY USE** the extra protection for several reasons. We see bigger cables, bigger capacitor banks and other evidence that arresters must bear heavier burdens at the regular transmission voltages. Also, it could mean new life for the older transformers whose aging insulation may require increased protection. So the free enterprise story gets another chapter as Dynagap 5 is introduced. And if free enterprise keeps on working, you'll probably see more improvements soon, both from O-B and from our competitors.

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OHIO BRASS

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O-B Hi-Tension News
JANUARY 1967

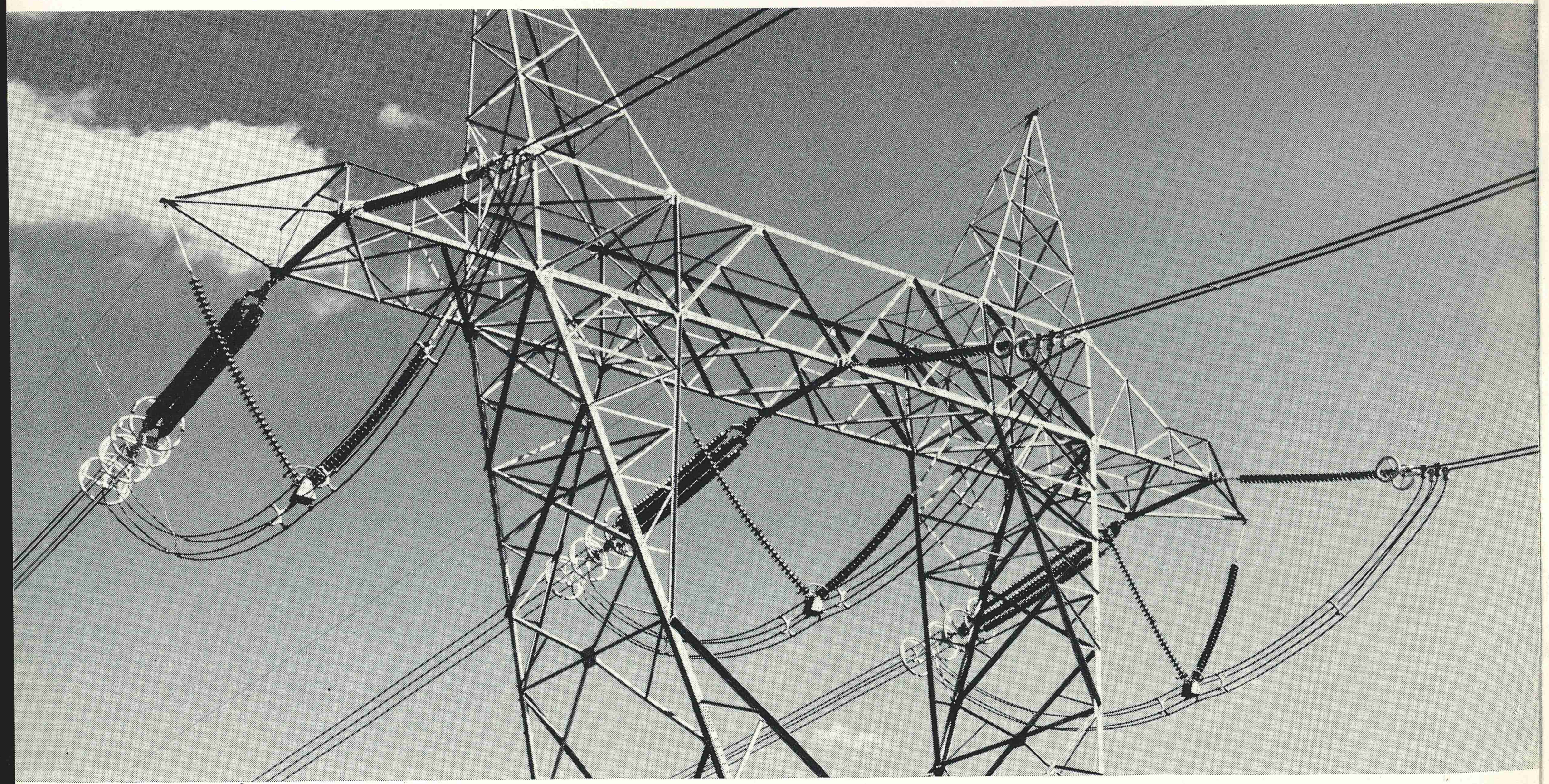
# Detailed study of Hydro-Quebec's special construction for 735 kv to be presented in Hi-Tension News

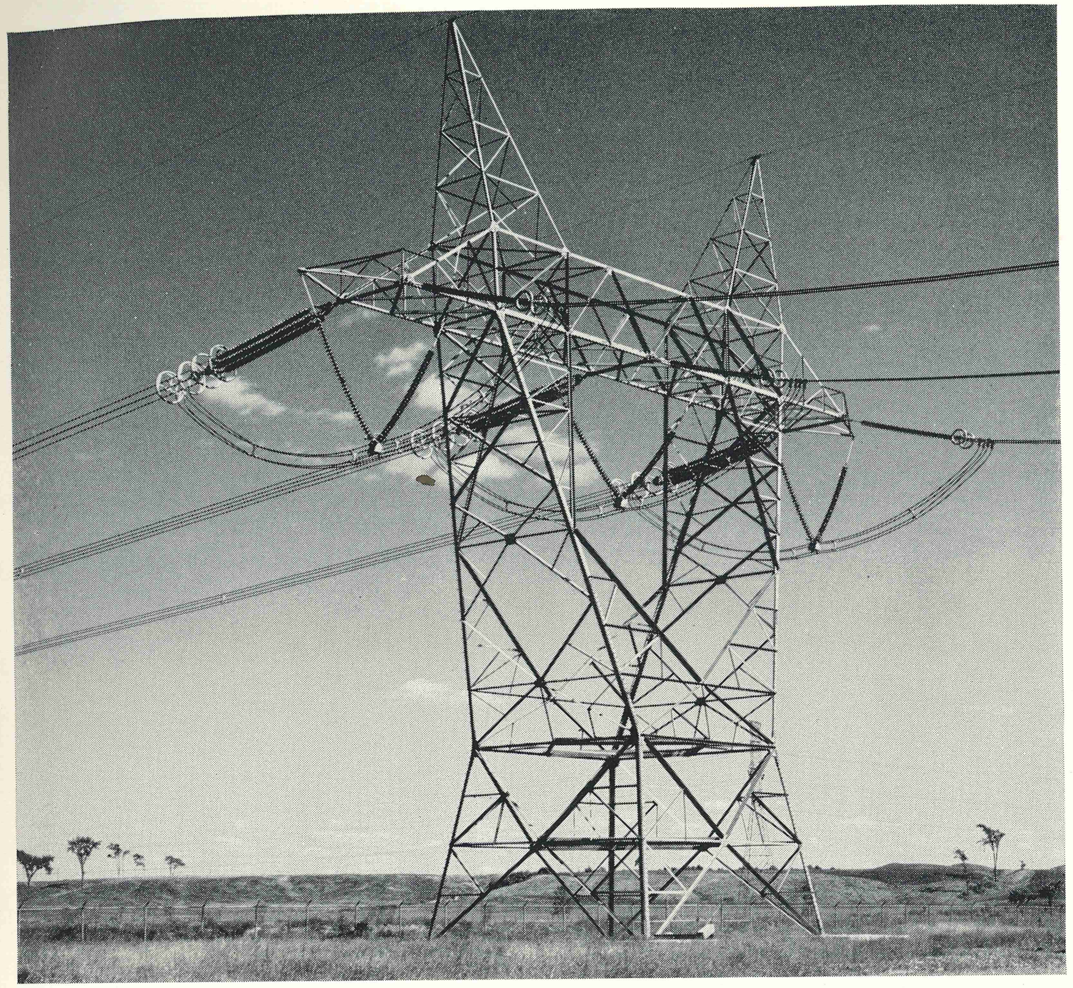
## Transition from four-conductor tangent bundle to station buses shown here as first of series

Whether a particular engineering department is contemplating EHV transmission above 700 kv, or whether this is still in the realm of fantasy, we feel sure that construction at these voltage levels holds a great deal of interest for many men dealing with system design.

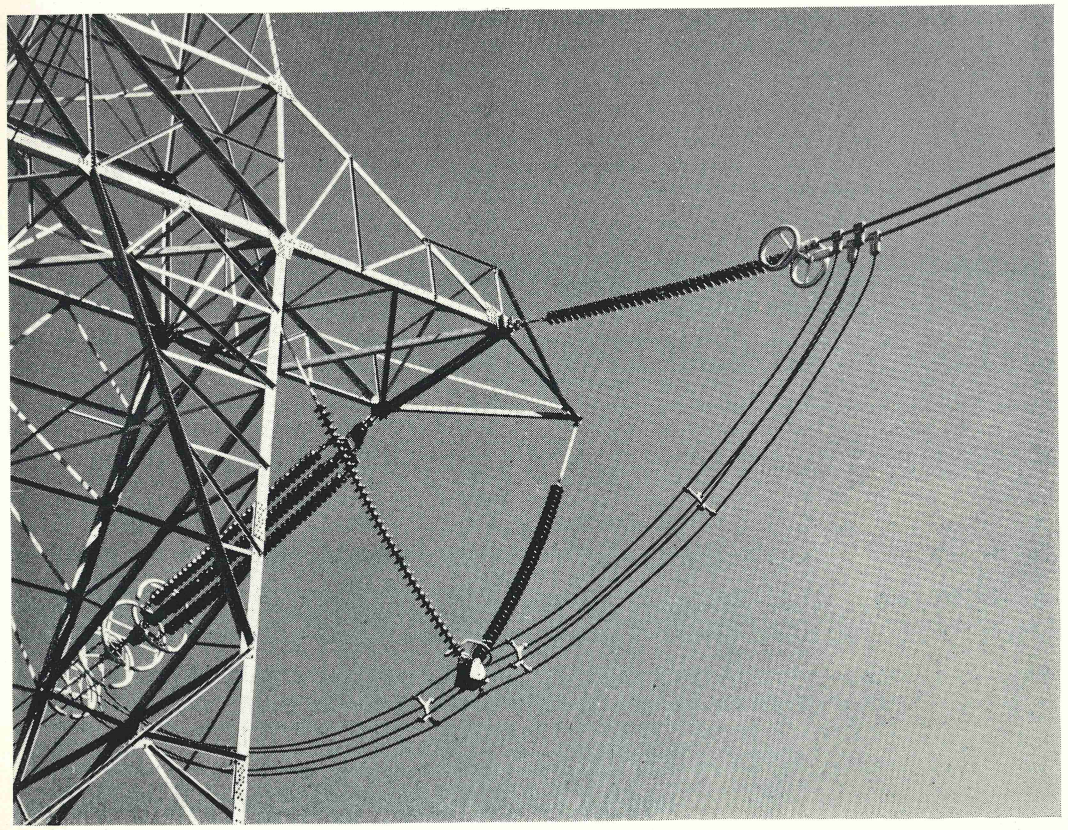
With this thought in mind it is planned to publish in Hi-Tension News an extensive series of photographs recently made specially for this magazine on the 735-kv project of Hydro-Quebec. In order to have space available to print these pictures sufficiently large for detailed study, the series will be presented in four parts: First, shown here, is the transition from the four-conductor bundle used on the tangent line to the twin bundle for tension buses in the station and, in

*(Continued on page 4)*





One of the terminal structures at the Boucherville Substation where two of the three 735-kv circuits feed the Montreal area. Note that V-strings are used to restrain side sway of jumper loops, thus materially reducing horizontal dimensions of the tower. Phase spacing is 50 feet. Anchorage of conductors is 110 feet above ground. The two following photographs show greater detail of the construction.



Hi-Tension News
JAN. 1967, Vol. 36, No. 1

ON THE COVER — O-B's Product Manager John B. Enrietto announces new Dynagap 5 station class arresters and points to the new current-limiting gap assembly which produces significant increases in arrester durability.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

(*Continued from page 2*)
turn, to aluminum tubular bus, as the circuit is broken down for various station apparatus. Second will be a study of a medium-angle corner, as used up to 30 degrees. Hydro-Quebec limits conventional running corners to angles of only a few degrees, and utilizes strain structures for most departures from tangent. Third is a complex high-angle corner as used up to 90 degrees. An idea of its elaborate design can be gained from its requirement for 1,050 insulator units. Fourth will be a detailed examination of the huge two-circuit crossing of the St. Lawrence River on deadends rated at 600,000-pounds per phase, including one phase under construction.

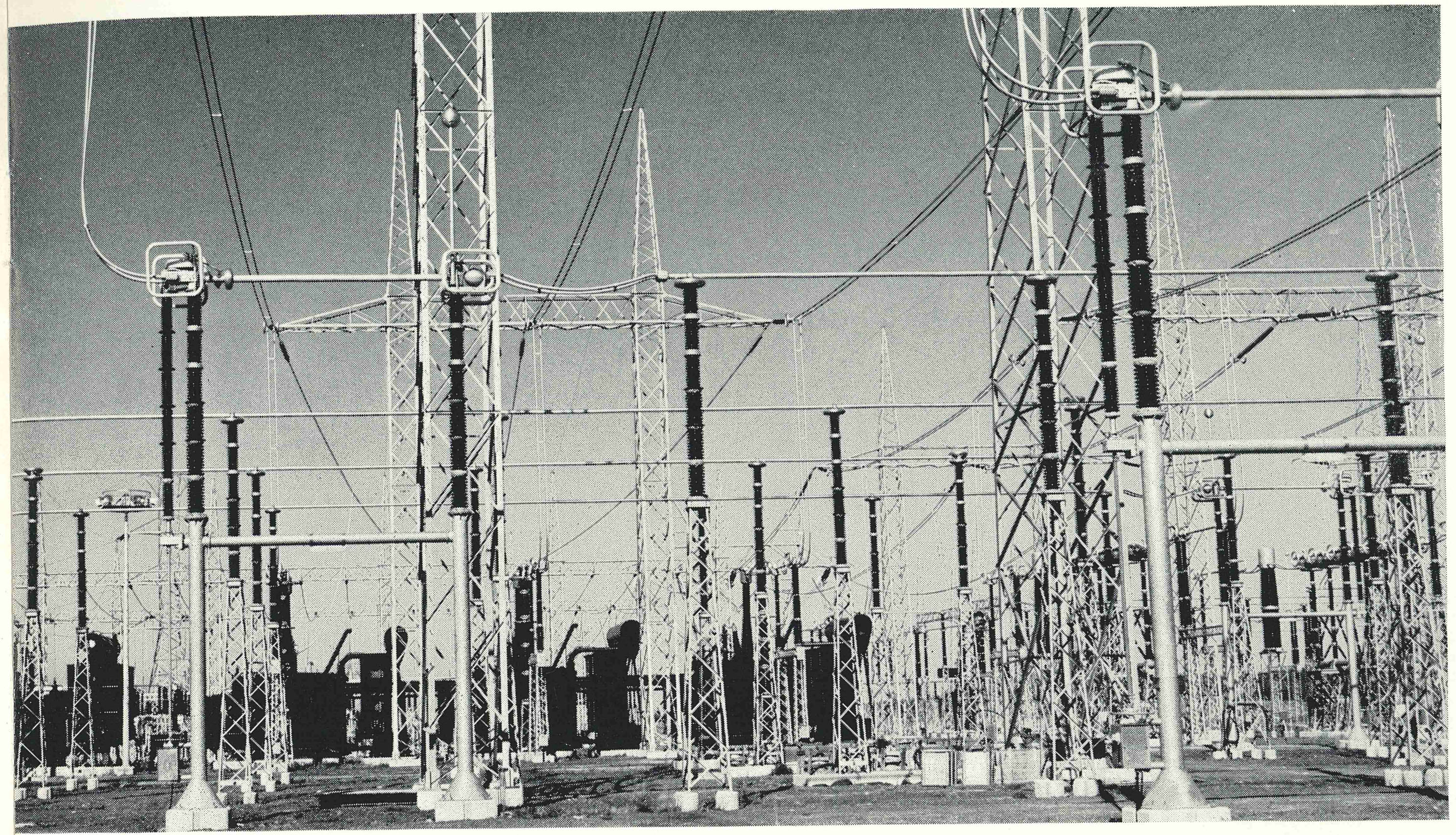
We believe this series of pictures will be interesting . . . perhaps even inspirational. Behind them lies a story of the complete feasibility of extra-high-voltage construction, with emphasis on the "extra".

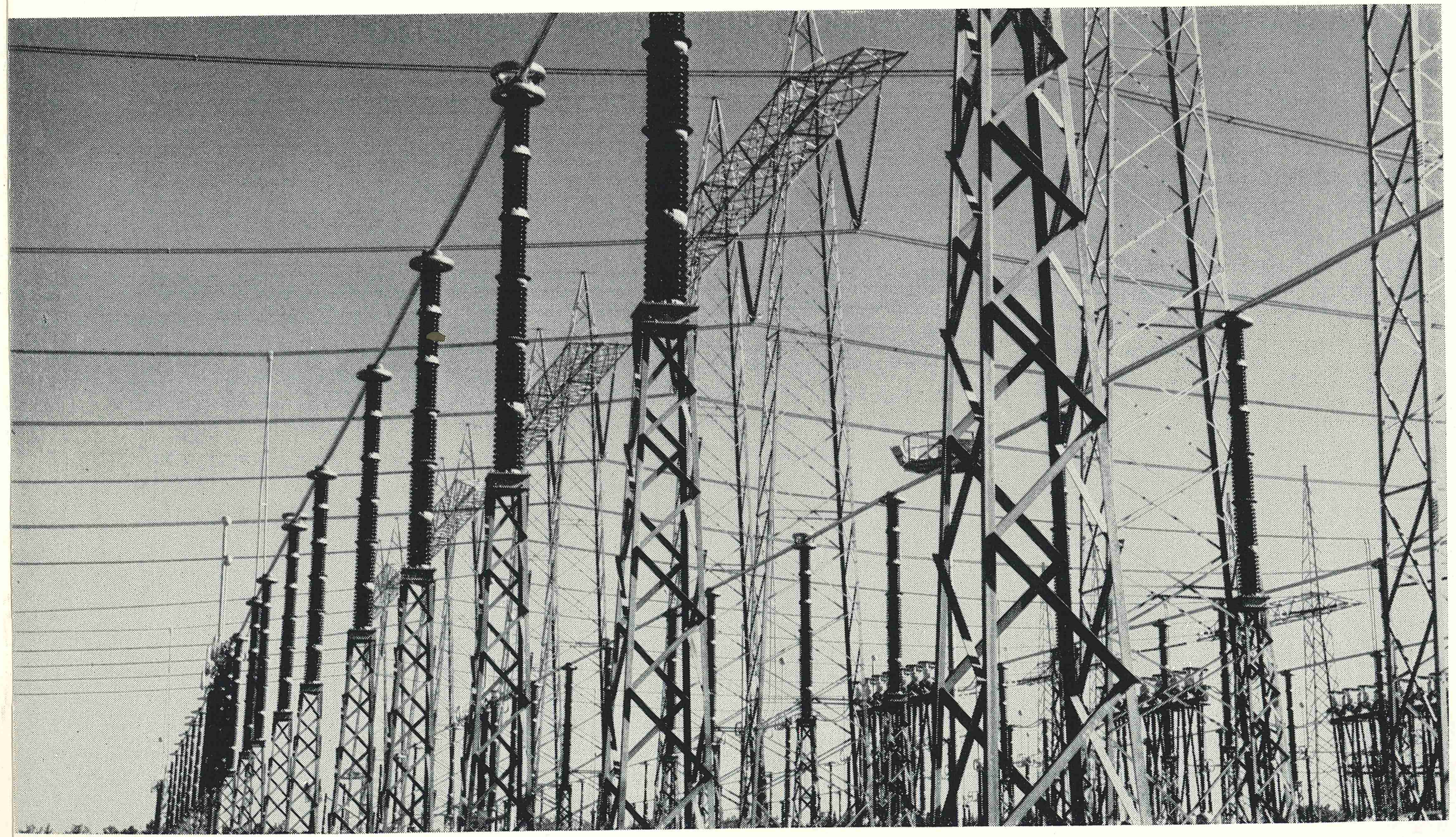
Aluminum tubular bus is fed in two manners. Shown here is connection from the overhead tension bus, through an air-break switch, to the tubular system. ▶

◀ The line enters the station at a high elevation on twin-conductor tension buses. This conductor arrangement is carried through the air-break switch to the O-B Thorex lightning arrester and, in turn, to the transformer bushing, immediately adjacent.

A second method of connection from overhead to the tubular bus, shown toward the background of the picture, is a jumper from the tension buses. It will be seen that a few of the O-B insulator stacks are equipped with double grading rings. These are for control at expansion joints in the tubular bus system. This installation, one of six such bays, is in the huge Levis Substation near Quebec City, one of the largest in area existing. ▶

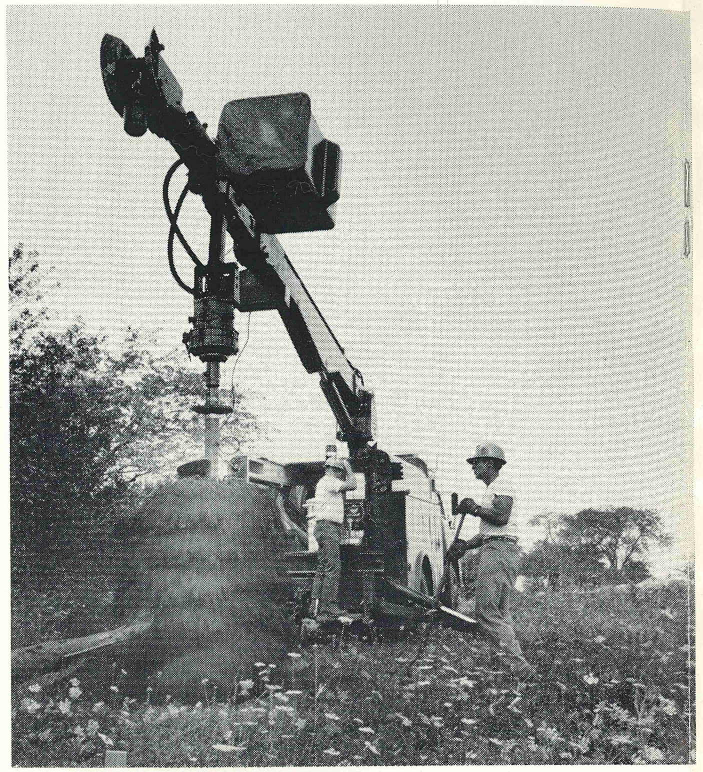






# A reason for waiting

## . . . five new units from Holan in '67



Holan's new heavy-duty Mustang 90 handles the increased working requirements on today's larger systems just like it was designed for the job — because it was! The new Mustang 90 is available in 29- and 34-foot bucket heights and offers an optional bucket attachment with a manual pull-out or pin-on boom.

Three different models in two bucket heights — 27 or 31 feet — offer you new flexibility for light-duty applications in Holan's new Bronco 87 series. Its single bucket furnishes a manload lifting capacity of 300 pounds.

Holan's Bronco 89 series offers two new bucket heights to round out the Holan product line. Available in 36- and 41-foot bucket heights, this new material-handling unit offers an optional fiberglass-reinforced plastic insert in the lower arm.

Holan offers you five good reasons to delay signing your 1967 purchase orders for elbow and derrick equipment. Each reason is a member of the new long, strong breed of work-horse equipment from Holan — two new Bronco elbows, two Mustang derricks, and a new two-speed earth borer.

Why wait? It's simple. Each new unit is currently gaining valuable and necessary field experience — experience which is proving the performance capability and design criteria of these new units through practical application. Utilities just like yours, with the same problems and job requirements, are proving the design criteria developed by Holan's research and development engineers — on the job. The orders? — "pick your roughest crew and put these new designs through your toughest work schedule." And, it's working — each new unit will be performance proved and ready for manufacture in the first quarter of 1967.

We mentioned engineers. All the new equipment from Holan for 1967 was designed and developed by the same engineers who gave you the Bronco 88, the one true material-handling aerial device; the Bronco 83, a small but versatile man-carrying elbow; and the Mustang 75 derrick coupled with the industry's most capable derrick-mounted digger — the 5400 that produces 9100 pound-feet of torque. The same care and design experience went into development of Holan's new equipment for '67.

Holan's new long, strong breed of power equipment will be available shortly after the first of the year. The premier showing and demonstration are scheduled for January 30 in Cleveland, Ohio.

Holan's line for '67 includes the performance-proved Bronco 85 and 88 plus the new Bronco 87 and 89 units. Several models are available in each new design series. The Mustangs 90 and 92 will both offer you a choice in derrick equipment with new sheave heights and lifting capacities. A new earth borer, the 5600, rounds out what's new from Holan, giving you added flexibility for equipping your Mustang derricks. Let's take a quick look at each of the new units.

In the Bronco 87 series, three different variations are offered in two model heights, 27 or 31 feet. Variations include an all-steel upper and lower arm, steel lower and fiberglass upper arm, or fiberglass upper arm and lower arm insert. A small compact unit the Bronco 87 offers an economical package with traditional Holan quality. The 87's double-hung bucket furnishes a man- and tool-load lifting capacity of 300 pounds.

Two new heights for Holan Elbows are found in the new constant-radius Bronco 89 series. These 300-pound capacity units are available in 36- and 41-foot models and each offers an optional fiberglass reinforced plastic insert in the lower arm.

For 1967 Holan offers a new heavy-duty derrick to handle the increased working heights and heavier loads required by today's construction techniques — with plenty of muscle to spare for future needs. Available in 29- and 34-foot sheave heights, the Mustang 90 offers an optional bucket attachment with a pin-on boom or fiberglass manual pull-out, plus the most complete offering of attachments available anywhere. Lifting capacities for the 29 and 34 units respectively are 17,000 pounds retracted, 13,500 pounds extended; and 13,500 pounds retracted, 10,500 pounds extended at maximum elevation. The Mustang 90 is not just another derrick! It's the combination of more than eight years of experience and proved features blended into a product to meet today's higher load and reach demands.

If you're looking for a smaller derrick, take a long look at Holan's new Mustang 92. With a 28-foot sheave height and capacities in excess of 9,000 pounds in the extended position, it's an ideal unit for getting into areas where the larger rigs can't go.

Two speeds! That's the newest feature of Holan's 5600 Earth Borer. One speed for digging with a 7,000-pound-foot torque rating, and a second speed which really spins-off the auger spoils. Designed to fit all Mustang derricks, the new 5600 earth borer incorporates a floating planetary gear train — the system developed by Holan years ago and so widely copied by others.

Before you decide on any mobile power equipment for 1967 check the many features of Holan's performance-proved units. We know you'll like what you see because it's all been designed to your specifications. For more information write: Holan, Division of The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.

# O-B plastic insulator offers time savings for distribution service

## . . . 50 years of successful low-voltage background too!

Plastic insulators are news, so we thought you might appreciate a new way to use one made by O-B. It's a technique employed by an Ohio utility and utilizes an O-B plastic insulator — one that's got 50 years of successful low-voltage service behind it.

O-B originally developed the Dirigo(R) plastic insulator for low-voltage service in mines and on trolley systems in the early 1900's. It has now found application in the electric utility industry through a unique method of constructing service drops. Here's how it works.

In distribution practice, a pole deadends a three-wire, single-phase service in a housing development. Several services drop from the pole. An O-B Dirigo insulator eye-nut fitting is used as a convenient deadend for the neutral of triplex service, and it does not ground the service rack. This special use is applied only where the angle of take-off from the pole does not permit deadending on the existing spool of the rack.

As a result, running a service drop from the opposite side of a rack no longer presents the difficult problem it once did for distribution crews. A lineman doesn't have to attach a spool and clevis to the rack bolt extended through the pole.

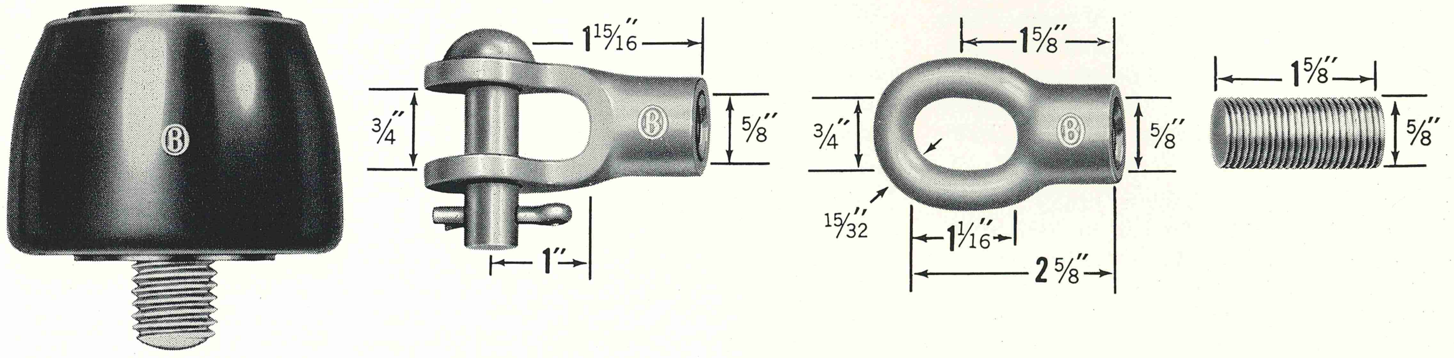
Now, with O-B's standard Dirigo insulator, Number 22479, a lineman carries one insulator up the pole with him. He can screw the insulator on the rack bolt and make the service drop. No hacksaw, rope, chain cinch, or other special equipment is needed. The lineman can save from 15 to 30 minutes per pole with this new idea in low-voltage service.

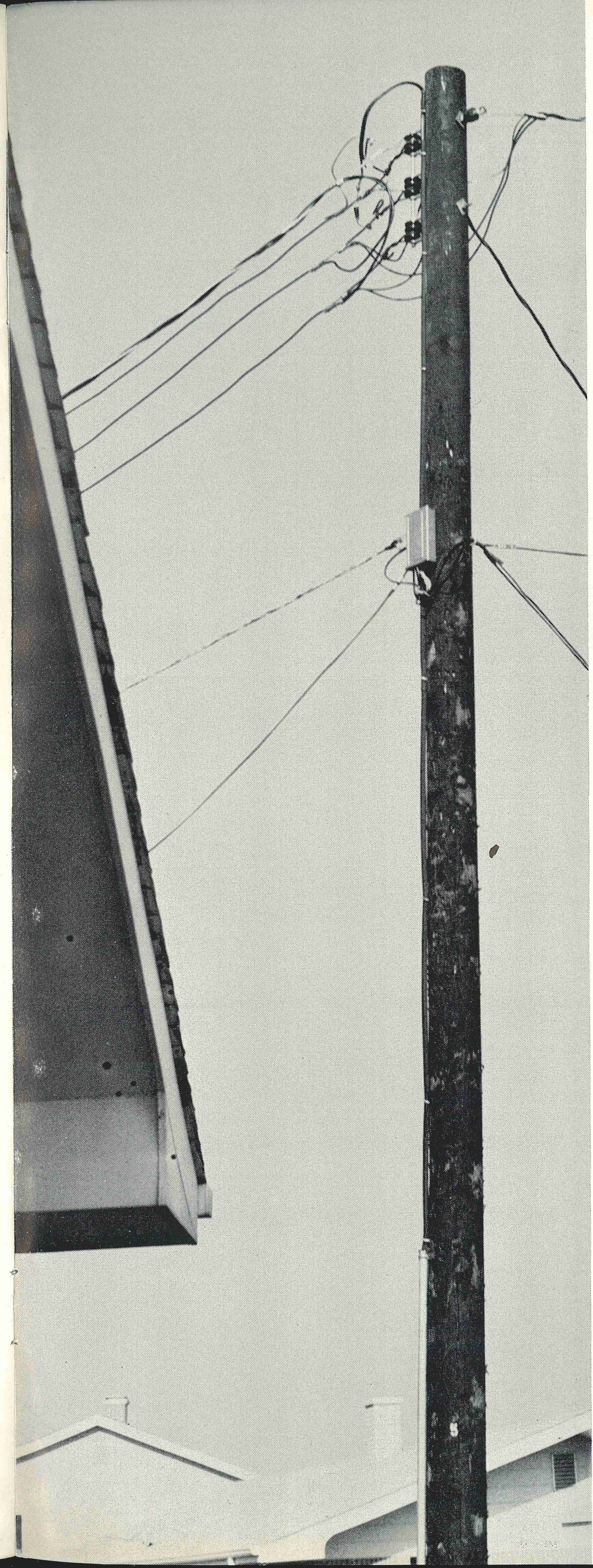
O-B's Dirigo insulators, Numbers 22479, 22810, and 52536 offer plenty of capacity for this kind of installation. They withstand tests of 5,000 pounds mechanically and 16,000 volts electrically. In addition to the natural corrosion resistance of the insulator body, the Dirigo is made up of parts protected by a coating of hot-dip galvanizing. In truth, Dirigos outlast the pole!

O-B lists the Dirigo on pages 115.3 through 117.2 in Section 100 of Mining Catalog 70. Each unit consists of the basic insulator body made of a special plastic with a ⅝-inch boss and an eye fitting, ⅝-inch stud. An eye is available with Dirigo Number 22479 which provides a neat guide for the service drop when it is screwed on the insulator's fixed stud. Various clevises and strain clamps are also available for tailoring Dirigos to your jobs. Once assembled, all that remains is to climb the pole and thread the Dirigo unit on to the machine bolt. The service drop is ready to go in a breeze.

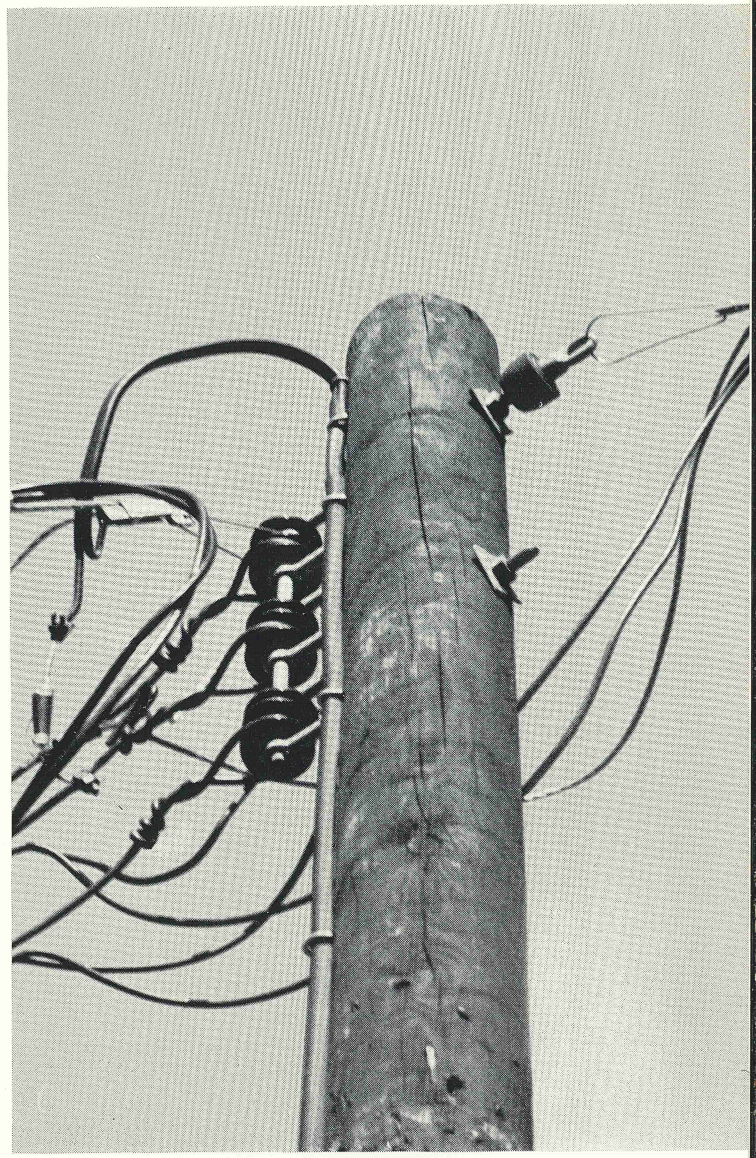
While the Dirigo unit costs slightly more than an ordinary spool and clevis combination, distribution men using the Dirigos find they save money in the long run through reduced installation time. Your lineman can do the same on your system. Write for more information on O-B's "new" 50-year old plastic insulator to: Ohio Brass Company, 380 N. Main Street, Mansfield, Ohio 44902.

Standard O-B Dirigo insulator Number 22479 threads on the exposed end of machine bolt. There is no cutting, fitting, or fiddling. The eye-fitting is easily threaded on the insulator stud and the service drop is ready to go.



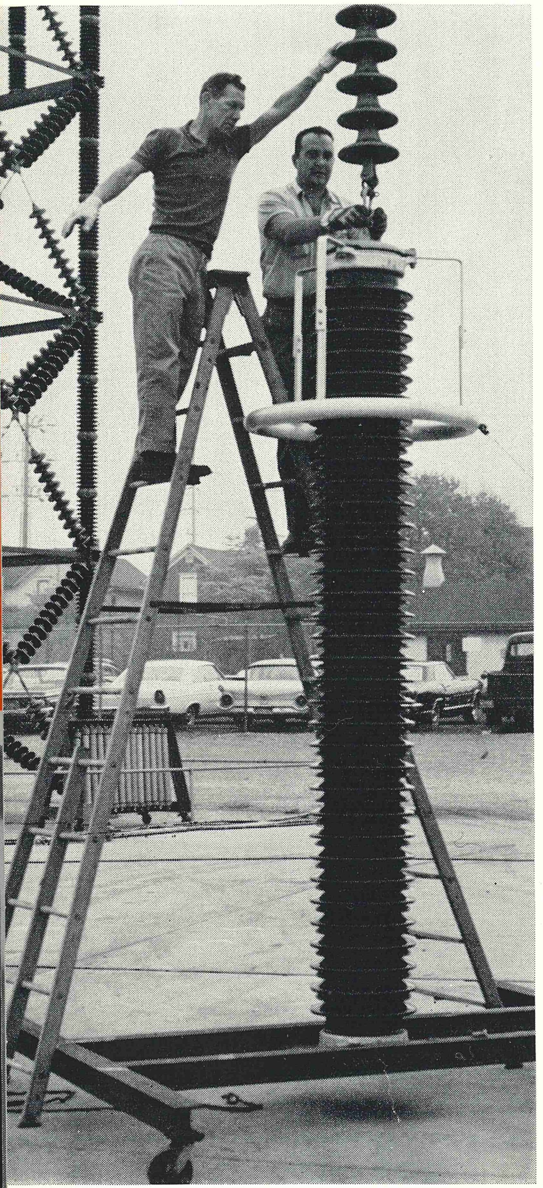
Dirigo units can be utilized on low-voltage service by almost any utility. Simplicity and neat appearance are significant application benefits.



Here's a close-up of a Dirigo installation — note the Dirigo threaded on to the rack bolt. One utility's crews save 15 to 30 minutes in construction of this simple service drop.

# O-B engineers set industry's highest goals in developing Dynagap 5 characteristics

## New durability standards result from substantial improvements in switching surge sparkover and discharge capabilities



▲ **Figure 1** — Dynagap 5 arrester is suspended on insulator string and elevated to testing position in O-B's High Voltage Laboratory.

O-B's original introduction of the current-limiting gap arrester in 1957 was, in retrospect, the gateway to all modern arrester protection. At that time incorporation of the Dynagap principle produced such significant improvements in operating characteristics that all previous guidelines to high performance arresters were for all practical purposes entirely obsoleted.

Because the original Dynagap concept presented such a revolutionary approach to arrester operation, its full potential in respect to the rapidly changing aspects of electrical transmission systems was temporarily overshadowed by the extent of its immediate benefits. Experience in application stimulated the further developments which disclosed important operating improvements through refinements of the Dynagap grading circuits, a situation leading to O-B's 1963 announcement of the Series IV arresters. Featured advance of the Series IV arresters was the introduction of its predictable, straightline sparkover response which extended from impulse through switching surge overvoltages.

Subsequent development of EHV variations of Series IV Dynagap arresters initiated pilot studies which indicated that additional modification and changes in the current-limiting gap could provide a substantial increase in the control of switching surges. Because of the importance of this specific capability in relation to insulation coordination and the anticipated severity of arrester discharge duty on EHV applications, development objectives for the new Dynagap 5 were clearly defined.

In recounting the research factors by which Dynagap 5 characteristics were established, a typical transmission system application was first chosen. Parameters for this particular system were:

1. 500-kv nominal voltage.
2. Insulation level of 1300-kv BIL (three-step reduction).
3. System charge voltage of 2.6 per unit.
4. 250 miles of integral line length.
5. Surge impedance of 300 ohms.
6. Capacitance of 0.017 microfarads per mile.
7. Applied arrester MPR-420 84%.

As is customary in research projects, a performance check list was used to pinpoint the areas in which present levels of performance should be maintained and those in which improvements would add the greatest benefits in application. This check list included the following items:

1. Arrester height and weight per kv rating.
2. Pressure-sensitive relief system.
3. Contamination performance.
4. Sealing technique.
5. Power frequency interruption.
6. IR discharge voltages.
7. Overvoltage interrupting ability.
8. Impulse sparkover level.
9. Switching-surge sparkover.
10. Transmission line discharge capabilities.

Series IV Dynagap arresters have demonstrated outstanding qualifications when referenced to the above list of performance factors. Thorex station-class arresters have maintained consistent leadership in the industry in relation to height and weight ever since the introduction of the current-limiting gap and the three-column construction of its internal elements. The present pressure-relief system has proved itself both by field performance and by thorough testing in the world's leading high-current laboratory. The sealing system of Thorex arresters has demonstrated itself superior to any other through an enviable record of field performance. Contamination performance, built around the concept of the one-piece porcelain housing with a stiff internal grading structure, leads the industry even under the most adverse conditions.

The current-limiting gap exerts complete control over power-frequency current interruption and accomplishes this function so efficiently that it has become of second order importance. Similarly, the reapportionment of interrupting duty, characteristic of the current-limiting gap, relieves the valve blocks of so great a share of their former duty in restricting follow-current flow that lower IR discharge voltages result and this area is no longer a significant factor. Impulse sparkover levels of the Thorex Dynagap arresters are consistently low values, providing adequate protective margins for all steep front voltage surges.

Objectives for Dynagap 5 improvements were therefore centered on extending arrester capabilities in respect to switching surge sparkover and the control of transmission line energy discharges.

Referring to the coordination diagram of Figure 2 and the insulation specifications established for this typical 500-kv transmission system, the need for the greater control of switching-surge sparkovers achieved in Dynagap 5 arresters is demonstrated graphically. In order to maintain the required protective margins under the three-step reduction in BIL, the arrester must limit impulse surges to 1080 kv and switching surges to 940 kv.

This improvement in control over switching-surge sparkover has been secured through a novel controlled sequence of operation in the Dynagap element. The combination of the predetermined order introduced in the gap function with the complete rearrangement of internal grading circuits produces dual benefits. As a result, more precise adjustments of both the power-frequency sparkover levels of the elements and the switching surge breakdown of the stack can be accomplished.

Utilizing this degree of control over power frequency and switching surge sparkovers, Dynagap 5 arresters are fully applicable to systems requiring close coordination of protective characteristics with sharply reduced insulation levels, thus fulfilling this important development project objective.

Close coordination of arrester protection implies adequate surge discharge capabilities, and it is in this area of redesign that Dynagap 5 possesses the broadest benefits. The current-limiting gap has the inherent ability to abruptly curtail the current flow initiated by switching surge sparkovers. An entirely new material has been selected for the enclosure in which the arc expansion occurs and extensive changes have been made in the gap arrangement. Electrodes have also been changed and respaced to produce optimum arc movement in response to the force of the magnetic field from the centrally located coil assembly.

The effect of the marked increase in the rate at which arc voltage is developed in the Dynagap 5 arrester is far greater restriction of energy discharges, effectively reducing thermal requirements of the arrester circuit. The left oscillogram of Figure 3 illustrates how the abrupt reduction of current occurs as a function of the extremely rapid buildup of arc voltage. The right oscillogram demonstrates that no perceivable change has taken place in the Dynagap 5 discharge cycle after being subjected to 20 consecutive operations under the prescribed test. No other known arresters have demonstrated these characteristics at their durability rating, especially at EHV levels.

Improved arrester durability is particularly significant in a broad range of industry applications in view of greater demands for system reliability, higher capacity equipment such as capacitor banks, and longer transmission lines and cables.

**Figure 2** — Coordination diagram illustrates graphically the required characteristics for the 420-kv Dynagap 5 arrester when applied to a 500-kv system with 1300-kv BIL (three step reduction). ▶

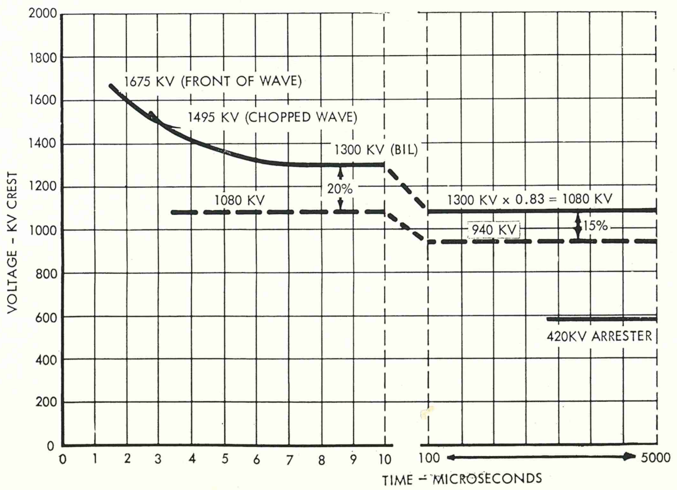
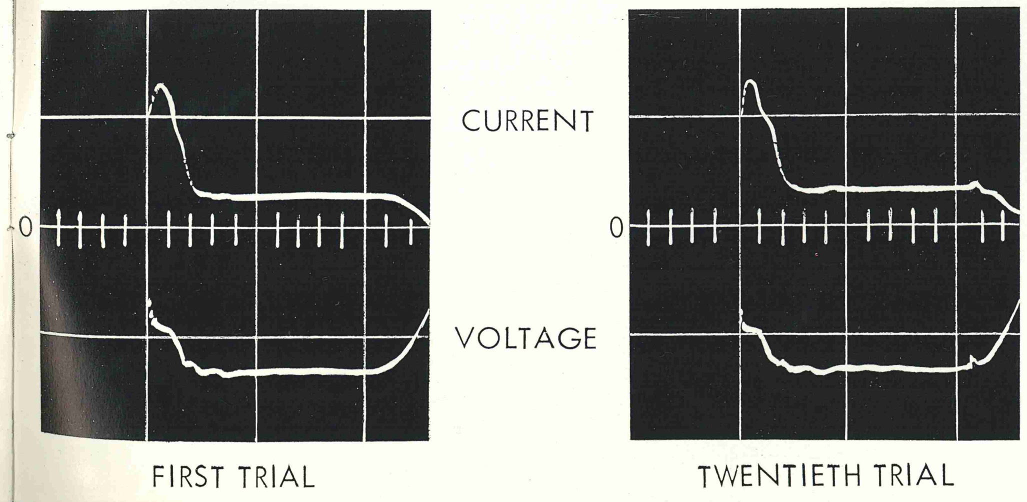



**Figure 3** — Oscillograms of rated transmission line discharge capability of Dynagap 5 arresters. Upper trace shows how abruptly current is restricted through rapid rise in arc voltage indicated by lower trace. Oscillograms after 20 consecutive discharges indicate no alteration in dis charge characteristics. ▶



OHIO BRASS MANAGEMENT REPORT

# EHV quiz: what rates at tail end of cost but near heart on reliability?

BY ROGER A. BLACK
PRESIDENT, OHIO BRASS COMPANY

"The reported total cost of this project is about $400 million. The cost of the transmission lines is stated to be in the order of $40 million. The cost of insulators required for this 800 circuit miles is estimated to be just over $1 million. This is .25 per cent of the total project cost and 2.5 per cent of the cost of the transmission lines."

**THE QUOTATION COMES FROM** a paper on "Trends in Insulation of High Voltage and Extra-High-Voltage Overhead Transmission Lines" presented to the Pennsylvania Electric Association winter meeting in 1953. You probably recognize the project as the OVEC-IKEC system.

**WE REVIVED THIS** 14-year-old comment to see how well the cost breakdown applies today. We note that the advent of V-strings and the development of new hardware to support bundled conductor have increased the percentage of line cost for the insulator-hardware system, but it's still well below five per cent. In fact, it's much less than the 10 per cent leeway which most utilities allow in their construction budgets. Or as was stated in 1953: "Less than the estimates for transportation and meals."

**AS TO THE RELATIVE IMPORTANCE** of the insulation, our 1953 speaker (an insulator man) modestly made his point this way: "The cost of the insulation represents only the hair on the end of the tail of the transmission dog while from an operating aspect it represents the very heart of that dog."

**ALL THIS LEADS TO** the contention that reliability—demonstrated reliability in the actual operating conditions imposed by service on U. S. EHV lines—

should remain the major criterion in selecting suspension insulators. Insulator reliability is even more important today as utilities install $100-million generating plants and 765-kv transmission networks. Failure of a single insulator—costing less than the price of a good lunch—could jeopardize the gains of this huge investment.

**AT THIS POINT YOU MAY AGREE** 100 per cent and protest that you would prefer to buy your transmission insulators from a supplier whose products have been proved many times over on U. S. EHV lines, but you can't get early delivery. In response, we are hopeful backlogs will diminish soon on suspension insulators and that waiting time will return to a reasonable period for reliable domestic insulators. If you seek counsel as to what the most reliable brand might be, I'll be glad to direct you to some experts with highly prejudiced opinions. 758-H

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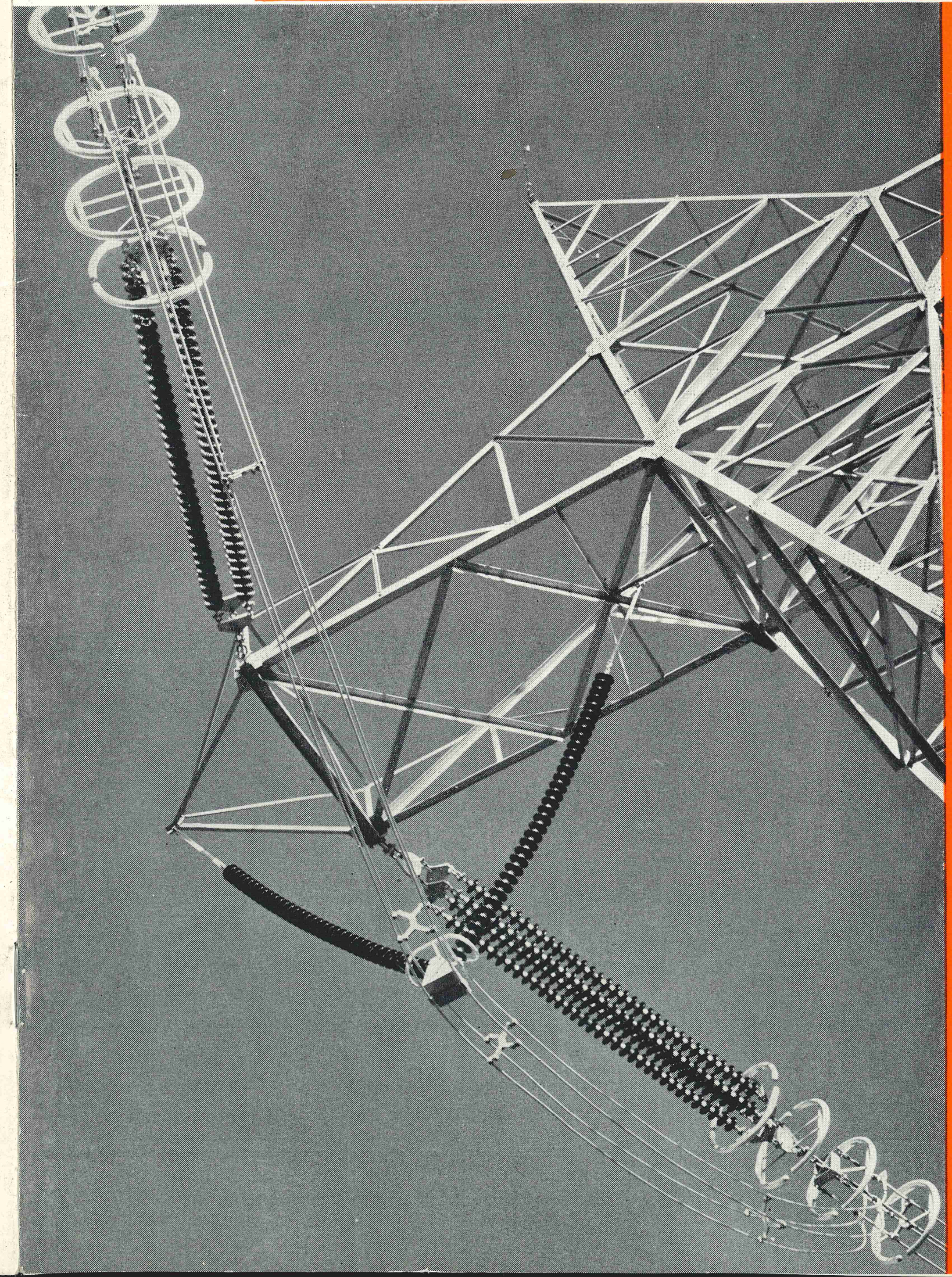
Hi-Tension News

FEBRUARY 1967



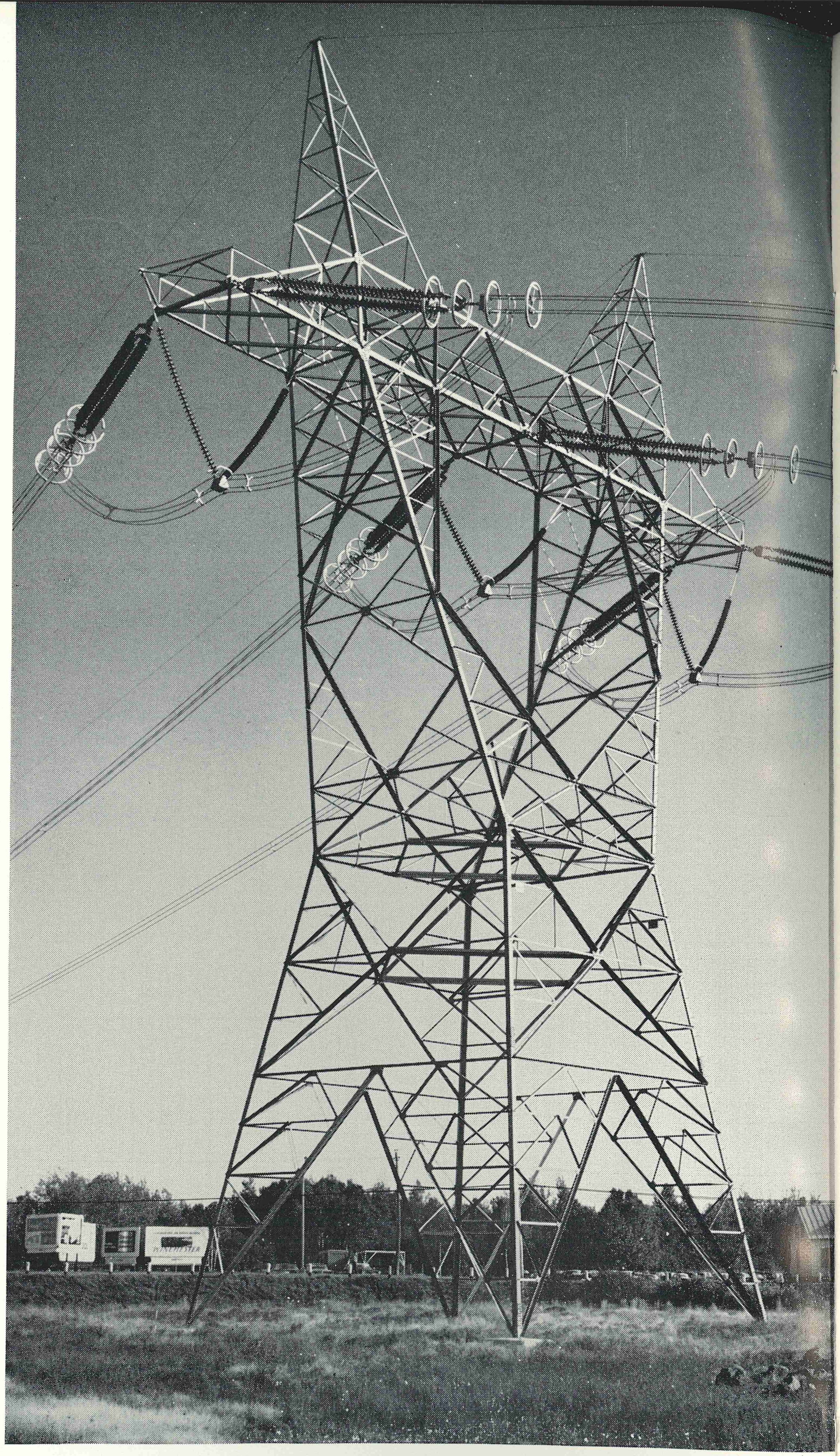
# Hydro-Quebec uses strain towers at practically all corner angles

Last month in Hi-Tension News we showed a series of pictures taken on Hydro-Quebec illustrating details of a station deadend tower and some of the 735-kv tubular buswork at the Levis Substation near Quebec City. The tower is interesting, not only because of its heavy construction, but also because it constitutes the transition from the tangent four-conductor bundle to a two-conductor arrangement used on high-elevation tension buses within the station.

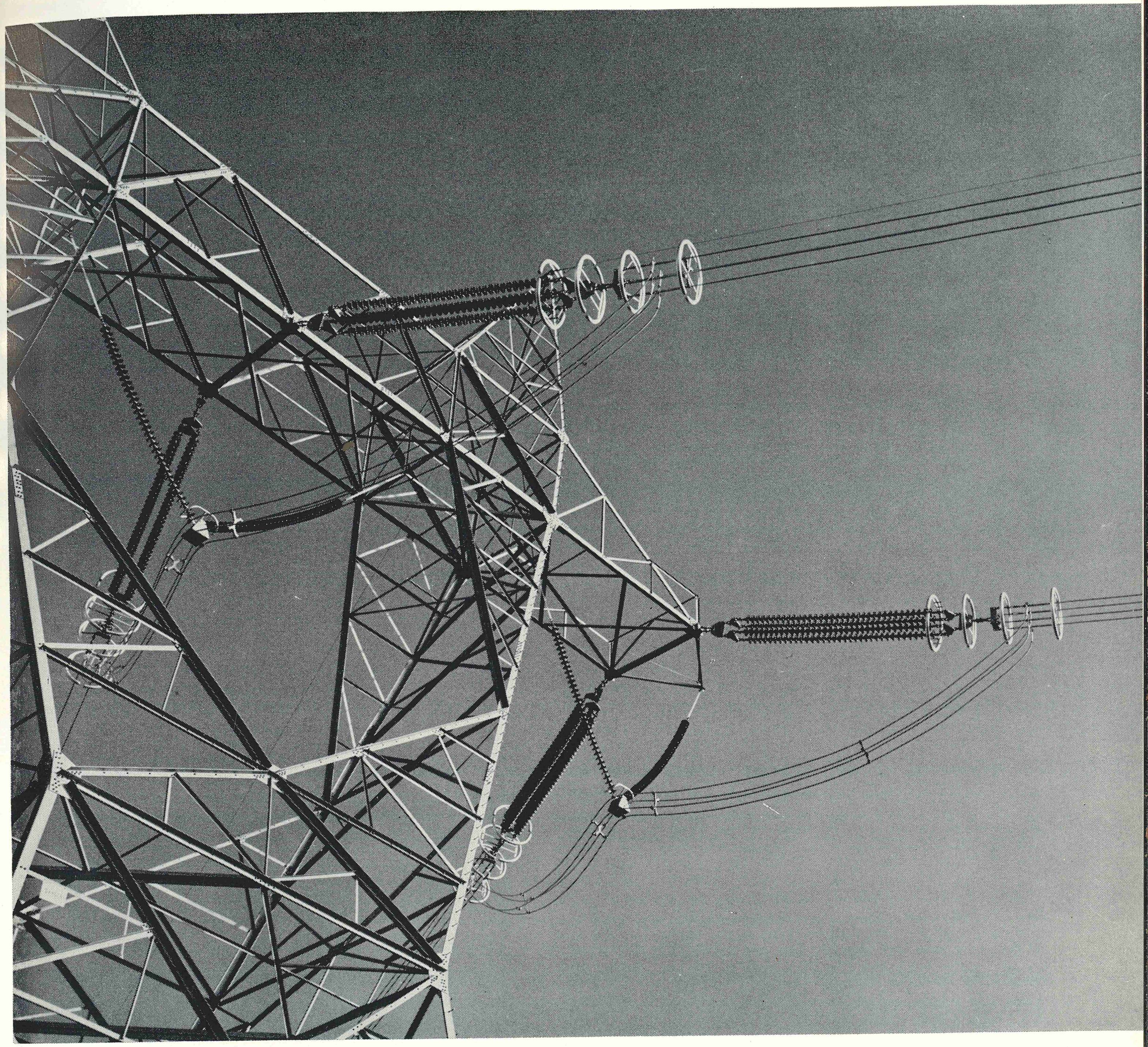
As a second step in this pictorial series we will study a low-angle corner. Hydro-Quebec uses simple corner construction only on very low-angle turns, and goes to strain towers at all higher angles. From approximately 15- to 30-degree angles the tower design shown here is used. Beyond 30-degrees, and up to 90 degrees, a considerably more complex structure is employed, which we will show next month.

To permit detailed study by those interested in certain design techniques, close-ups of the crossarm

*(continued on page 4)*



Type of strain tower used by Hydro-Quebec for angles of 15 to 30 degrees. This tower follows the practice applied throughout the line of 50-foot phase spacing and anchorage of conductors 110 feet above ground. The structure is un-guyed.



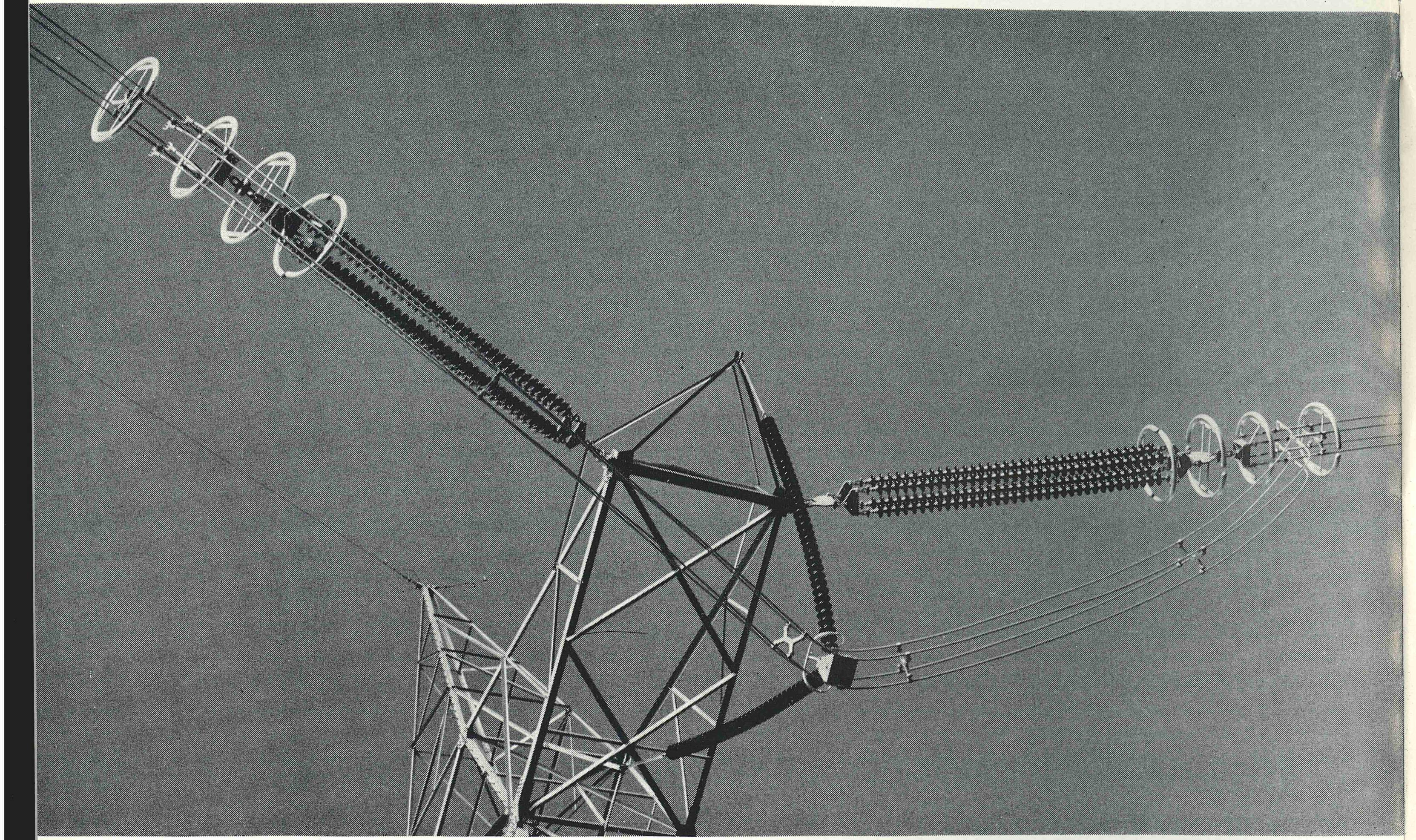
Tower top detail permitting a closer study of deadend and jumper-loop construction.

Hi-Tension News
FEB. 1967, Vol. 36, No. 2

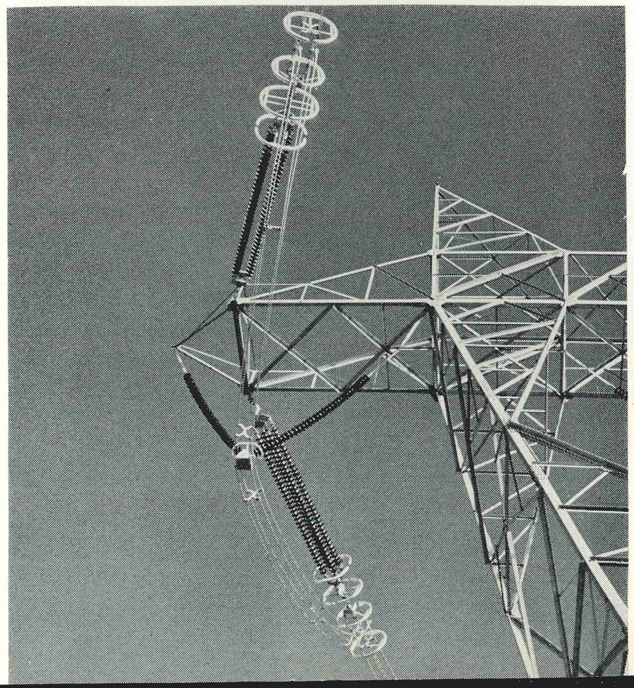
**ON THE COVER** — Detail of construction on 15 to 30-degree angle tower used on Hydro-Quebec's 735-kv project consisting of three circuits totaling over 1,000 miles.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

(continued from page 3)
and of both the inner and outer phases are included. Bottom of this crossarm is 110 feet above ground. Phase spacing is 50 feet. To restrain lateral movement of the jumper loops, V-strings are used. It will be noted that these are artificially loaded by weights in order to keep the "V" in a reasonably taut position under the light weight it would normally support. These metal weights are fully contained within the cage formed by the four conductors and are thus totally shielded against corona and RIV.



Inner phase. In order to maintain relatively taut V-strings under the light loading of the jumper loop, heavy weights are suspended from the hardware. Since these weights are within the cage of the four conductors, they are completely shielded.



Outer phase construction. Use of V-strings gives positive positioning of the jumper loop at the desired tower clearance. If this loop were not so restrained, the crossarm would have to be materially longer, thus affecting over-all design of the tower.



# Holan's new Mustang 90 Derricks . . .
## . . . give you deep holes fast
## . . . lift your heavy loads high

Dig the hole — set the pole. For heavy-duty jobs, it's Holan's new Mustang 90 Derrick, available in 29- and 34-foot sheave heights.

A natural evolution! That's Holan's new Mustang 90 Derrick — designed to meet today's trend toward taller poles, deeper holes, and heavier hardware-handling assignments. Incorporating many service-proved design concepts, the new 90, series derricks offer added lifting capacity, along with additional down-feed force and rotational torque for optimum operation of earth-auger attachments.

Available in sheave heights of 29 and 34 feet — models 29 and 34 respectively — with three mounting configurations, the new Mustang 90 Derricks offer the bare brawn and raw, brute strength needed to set poles up to 85-feet long. And, their strength also pays off when hanging heavy hardware and setting large transformers.

Count on peak performance from all the new Mustang 90 models. Holan engineers designed them for rugged duty on a chassis meeting minimum requirements — mounted R. H. R. C., C. B. O. C., or C. O. R. A. At maximum boom angle, the Model 29 has a 13,000- to 17,000-pound lifting capability, while the Model 34 lifts 10,500 to 13,500 pounds in the same position. In the flat-out horizontal position, the Model 29 is rated at 3600 to 5500 pounds, while the Model 34 is rated at 2,500 to 4,000 pounds.

"Put the muscle where it's needed" — that was the prime objective of the Holan engineers who designed the new heavy-duty Mustang 90 Derricks. For example, the boom is built on the uniform stress principle to distribute lifting stresses and strains over the entire boom length — reducing stress concentrations. And, high-tensile steel increases boom strength - to - weight ratio while reducing deadweight.

Another design objective — increased side-pull capability in the time-tested and field-proved 365-degree rotational mechanism — was achieved in the Mustang 90 series. Side-pull capabilities of the Model 29 measure 1000 pounds with the boom retracted, and 600 pounds with the boom extended. In the same boom positions, the Model 34 is rated at 690 and 470 pounds respectively. When side pull exceeds 120 per cent of rotational system capability, an overload protection system cuts in to prevent equipment damage.

Stability while handling aerial loads is assured with the new Mustang 90 Derricks. The rotation gear is mounted inside the rugged base frame for a low center of gravity, while strong, wide-stance stabilizer jacks are integral with the base frame. Low profile design, plus storage of all derrick components inside the body side boxes, helps furnish a "clean-line" configuration and permits greater transport convenience on and off the highway. Positioning of stored derrick components is particularly advantageous on R. H. R. C. units — providing a convenient bobtail mount, yet a full-line body for parts storage. This feature also permits pole-walking over the rear of the vehicle, and leaves the body end open for storage of long materials.

Many options will help you exploit the Mustang 90's flexibility. Select from a wide range of time- and labor-saving packages. For example, choose an earth borer from various torque ratings — as high as 7,000 pound-feet. Select one of the mechanical or hydraulic tilting pole claws for positive control in lowering, with no need for piking. You may want your Mustang 90 equipped with a multi-purpose sheave head that permits use of a boom tip winch — or attachment of a barrel sheave in addition to pole-setting flares. You can also select a six-, eight-, or ten-foot fiberglass mechanical pullout or pin boom — equipped with a fiberglass bucket if you like, mounted in either of two positions on the ten-foot boom. Or, you may like to specify remote controls for operation of the derrick from the bucket.

To add further versatility to your Mustang 90 Derrick, Holan offers a 10,000-pound pull winch — boom or bed mounted. And, Holan's exclusive, full-time hydraulic safety overload device is available to prevent equipment damage in the event of derrick, winch, or earth-borer overload.

Take a look at *your* work schedules. See a place where the versatile, heavy-duty performance of a Mustang 90 Derrick would fill the bill? Get all the facts and an on-the-spot demonstration. Write or call Holan Division of The Ohio Brass Company, 4100 West 150th Street, Cleveland, Ohio 44135.

# Progress makes industry's efforts worthwhile

## From gaslight to 765,000 V in 84 years is just a matter of progress . . . or is it?

We can record inventions, inventors, patents, and original trials, but can we ever record the energy of effort and the frustration of failure of the men whose minds and labors gave us the difference between the flickering firelight of yesterday and the beneficial brightness of today?

When we give recognition to all the names of men who have in one form or another been recorded as aiding in the development of electric power, we should also consider the men whose names have not been recorded, who are now and will be in the years to come, involved in the evolution of electric power.

These are the men in scientific research and development, product manufacturing, and utility management, who have made, are making, and will continue to make possible the benefits every American enjoys from electric power.

Electricity powers progress. Electricity is the result of the men, their ideas, dreams and decisions. They give us today, as their forefathers gave those who preceded us, the impetus to make electricity work for us. It is by them and through their labors we continue to realize greater goals through the power of electricity.

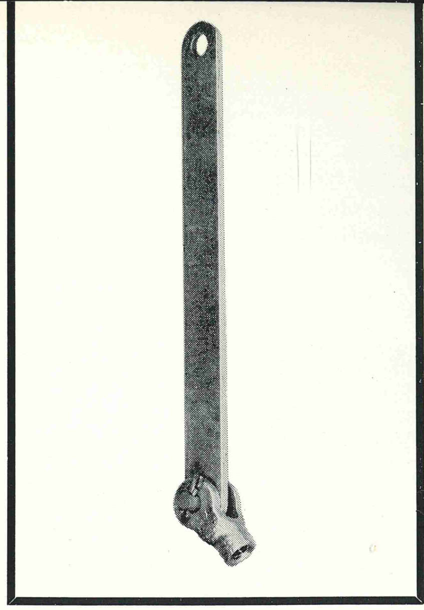
Ohio Brass takes this occasion to join its utility customers and manufacturing associates to acknowledge the great wealth of comfort and security their efforts have achieved in the application of electric power.

With enthusiasm we salute National Electrical Week, February 5 - 11, and pledge our continuing support of those endeavors which will eventually bring forth the realization of the great dream for electric power.

Electricity Powers Progress — and it is Progress that makes all men's efforts worth while.

NATIONAL ELECTRICAL WEEK

FEBRUARY 5 - 11, 1967



# O-B introduces new distribution extension assembly

Now Ohio Brass offers you an economic alternative to the clevis tongue.

Designed for installation between the deadend suspension insulators and the pole, O-B's new extension assembly Number 96021 offers you the same space-savings advantages as the clevis tongue at an appreciable cost saving.

The highly functional extension assembly, rated at 10,000 pounds, is a quality-built, sturdy piece of O-B hardware.

It has all the features you expect in O-B hardware products: a heavy - duty H. D. G. coating, a clevis designed to couple with a ⅝-inch pole bolt, and a strap suitable for joining with a clevis-type distribution insulator.

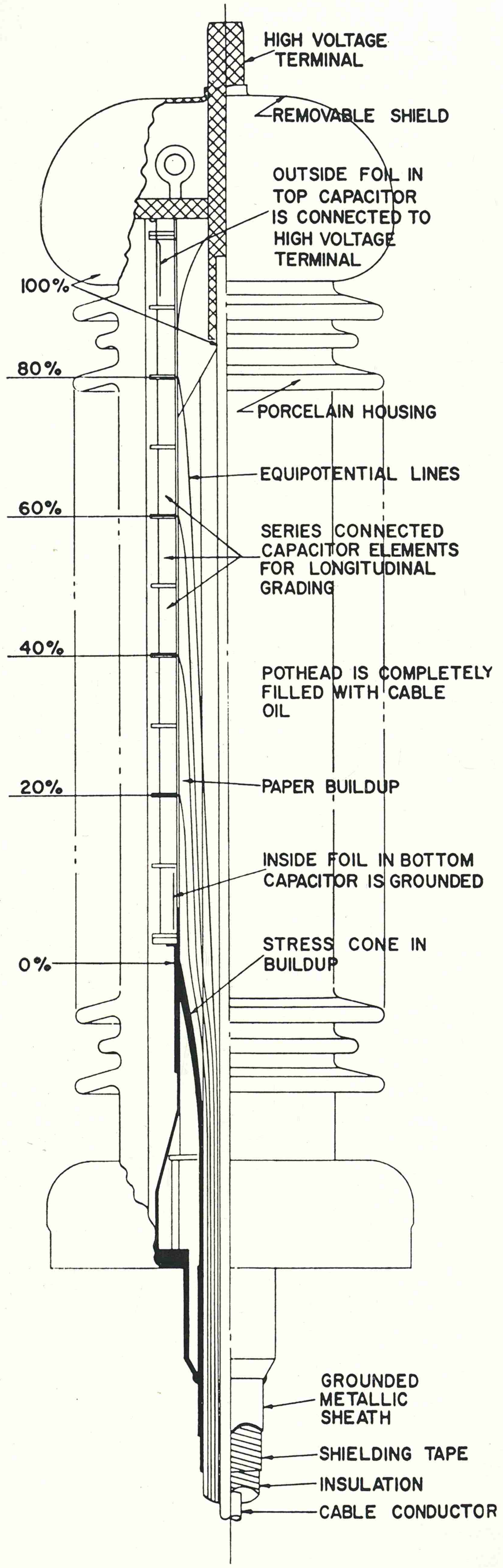
Models are available in strap lengths from 10 inches to 20 inches.

Ohio Brass is the only manufacturer of insulators that also makes hardware items — clamps, clevises, and component parts.

O-B's new extension assembly was developed by the same O-B team of engineers who design insulators and other hardware.

You can order the extension assembly from your O-B district manager or from your Graybar sales representative.

Ask for O-B, Our Best.




Text explains principles of capacitance grading and function of stress cone in controlling voltage concentrations.

# New O-B Bulletin discusses principles and application of transmission voltage potheads

Interested in or concerned with underground transmission? Want to know more about transmission cables and cable terminations? If so, you'll find the answer to many of your questions in O-B's new booklet, "Elements of High Voltage Pothead Application." This 24-page booklet summarizes a series of articles written by F. R. Stockum, O-B development engineer specializing in cable terminations.

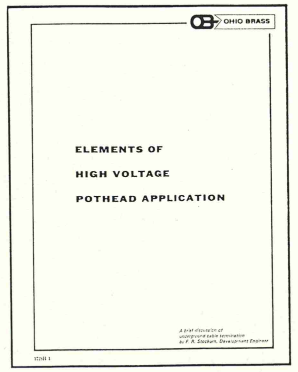
Background information on cables and cable insulation precedes a more detailed explanation of how control is established over voltage gradients at the cable terminals. The functions of the stress cone and grading systems in securing uniform distribution of voltage stresses are illustrated and described in semitechnical terms.

The brief description of the design and construction of O-B's capacitance-graded potheads for medium (69 through 161 kv) and high (230 and 345 kv) transmission voltages which follows relates their principal features to the general discussion of termination requirements.

Actual work involved in making pothead installations is covered by step-by-step photographs of the field operations. Two groups are illustrated, since procedures differ for the installation of the medium- and high-voltage pothead models.

Copies of the O-B booklet are available to utility engineers and other interested personnel simply by requesting Publication 1728-H from your local Ohio Brass district manager or writing directly to The Ohio Brass Company, Mansfield, Ohio 44902.

Descriptive booklet covering the principles of cable terminations and the equipment used in actual installations is available by ordering O-B Publication 1728-H.



# "Made together to work together"

- Extra long U-bolts make O-B Stratelines easy to handle on the pole

Headlines — out of the past — of Ohio Brass advertisements which you have undoubtedly read as you leafed through the pages of the popular industry trade journals.

Did you ever stop, however, and consider how *many* headlines announce Ohio Brass hardware? And what all these headlines might mean if listed together? What they might mean in "savings" to you and your company?

Well, first consider this fact about Ohio Brass hardware.

"Ohio Brass is the only manufacturer of insulators that also makes hardware items — clamps, clevises, and component parts."

*You* benefit from this "unique" situation by having hardware designed and developed by the same "team" of engineers who design and develop O-B insulators. Both insulators and hardware are "made together to work together" as a system.

You have the advantage of one dependable source of supply.

You know the O-B components fit and look good together, perform well, and help to reduce line maintenance.

In addition, you have available a selection of "standard" components to satisfy almost every distribution requirement.

Take the O-B Strateline series, for example. They have been designed with installation requirements in mind.

The U-bolts have been made "extra long." Consequently, they are easier to handle on the pole. They are also extra large and especially strong but easily "drawn down." The clamping action of seat maintains full holding power.

A "waved" clamping seat embodies the basic principle of a snubbed grip. This greatly enhances the normal holding strength of the clamp. Clamping is done with a minimum of strand deformation which can seriously weaken conductors.

The body metal of the O-B Strateline consists of high-strength aluminum alloy, especially selected for strain-clamp application. The body strength is appropriately increased at main points of high mechanical stress. (Malleable iron and bronze bodies are also available.)

The stainless steel, humpback cotter key will never corrode. "Guided" for quick insertion, it holds tightly without spreading. It's also easily withdrawn and replaced with hot-line tools.

The rounded U-bolt ends and well-chamfered nuts eliminate sharp edges that can cause radio interference. Nuts thread on more easily too.

There is, in addition, a solid, high-strength keeperpiece permanently attached to both U-bolts. This captive design results in fewer parts to handle and less danger of dropping pieces during installation.

Clamps in the O-B Strateline series can be obtained to cover a range in conductor diameter of 0.15 to 1.55 inch. Strength of various clamps matches these conductor capacities with generous safety factors.

Finally, when shipped, every clamp is firmly tightened over a wood insert. This avoids loose parts and possible loss of pieces in handling U-bolt threads are less likely to become damaged in cases of extreme abuse.

The *O-B Universal Strain* Clamp, Number 88500, has been designed with the lineman's installation problems in mind.

As a result it has universal appeal for distribution men.

The O-B Universal stays open automatically until the clamping nuts are tightened. A special spring on the clamp holds the clamp jaw and body as one piece during installation. This eliminates loose-parts problems and saves time.

The clamp also has a snubbed grip. The jaws need not crush the cable to develop maximum holding power. If cable must be resagged, previously gripped area will be scarcely noticeable and completely undamaged.

The major grip on the cable, developed by snubbing around circular seat, produces a holding strength, without slip, equal to the ultimate of most cables.

The clamp seat provides positive offset to prevent the contact of the cable at the crossover point. No rubbing or chafing of strands can occur.

The shape of the seat brings the cable into position to complete the jumper loop with a minimum of hand forming.

Rounded, well-finished nuts and U-bolt ends plus hexagonal clevis rivets keep down the radio noise. Nut threads on more easily.

The "guide" design of the O-B cotter key permits the cotter to be slipped into the rivet quickly. The "humpback" design prevents the key from retracting once the "spring" effect has spread the ends.

If the clamp is worked with hot-line tools, the key is easy to insert and withdraw. But, it will never fall out. Pointed ends facilitate installation.

The clamp never needs to be



- Slender profile of this O-B deadend combination gives you added clearance
- One wrench fits 'em all
- Special spring on O-B Universal holds clamp open, saves time and trouble
- Biggest clamp buy in the small-size distribution range

taken apart; it goes from manufacturer to installation in one piece.

The O-B Universal Strain Clamp Number 8800 accommodates the conductor sizes of: ACSR, 5 to 2/0; all aluminum, 4 to 3/0; Rated ultimate strength of the Universal Strain Clamp is 10,000 pounds.

The "biggest clamp buy in the small-size distribution range" is the O-B L-W Cooline Clamp Number 86534.

This rugged deadend clamp was designed for versatility in its application to short spans and low mechanical tensions common in distribution systems.

The body metal of the clamp consists of a high-strength aluminum alloy especially selected for strain-clamp application. Its body is properly strengthened at points of high mechanical stress.

A waved, clamping seat embodies the basic principle of a snubbed grip. This greatly enhances the normal holding strength of the clamp. While this clamp is capable of breaking, without slip, almost any cable it will accommodate, holding is done with a minimum of strand deformation that can weaken conductor.

Extra-long and extra-strong U-bolts draw down easily and give a clamping action that maintains full holding power.

A solid, high-strength aluminum keeperpiece is permanently attached to each U-bolt. This "captive" design results in fewer parts to handle, and less danger of dropping pieces during installation.

A stainless steel, humpback cotter key will never corrode. It's pointed for quick insertion. Holds tightly without spreading. Is easily withdrawn and replaced with hot tools.

Rounded U-bolt ends and well chamfered nuts eliminate sharp edges that can cause radio interference.

Clamps in the O-B Type-L-W series can be obtained to cover a range of conductor diameters of 0.20 to 1.30 inch. Strength of various clamps matches these conductor capacities with generous safety factors.

When shipped, every clamp is firmly tightened over a wood insert to avoid loose parts and possible loss of pieces in handling and to protect U-bolt threads from damage in case of extreme abuse.

All ferrous components of O-B clamps and hardware fittings are hot-dip galvanized. These coatings adequately meet the requirements of ASTM A153 "Specification for Zinc Coating (hot dip) on Iron and Steel Hardware."

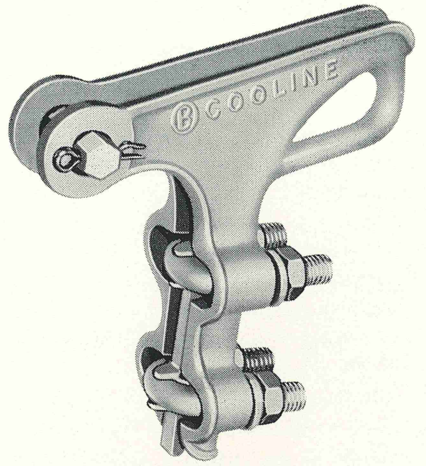
Thread dimensions on U-bolts are standard after galvanizing. Nuts are dipped in "No-Ox-Id" to both protect and lubricate.

O-B clamps can be identified by the pattern number cast into each part, and the range of conductor diameters is permanently cast into the clamp body for convenient reference.

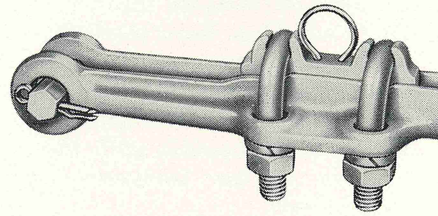
Finally, many O-B clamps and fittings are packaged in standard quantities which are limited in size and weight to permit easy handling by one man.

*Variety, Versatility, Quality* - and *Uniformity* combined in the design in the design and development of O-B clamps and fittings give you the *"best"* man can make and money can buy.

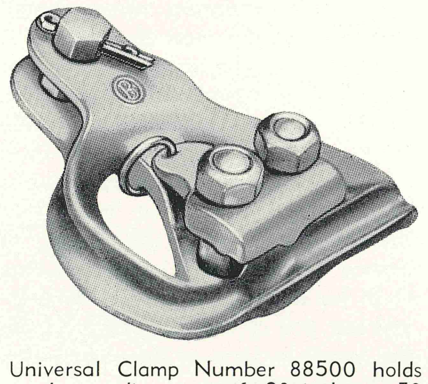
Remember O-B, *OUR BEST!*




The O-B L-W Cooline Clamp, Number 86534, covers a range from .20 to .47 inches in conductor diameters. Ultimate strength is 7,000 pounds.



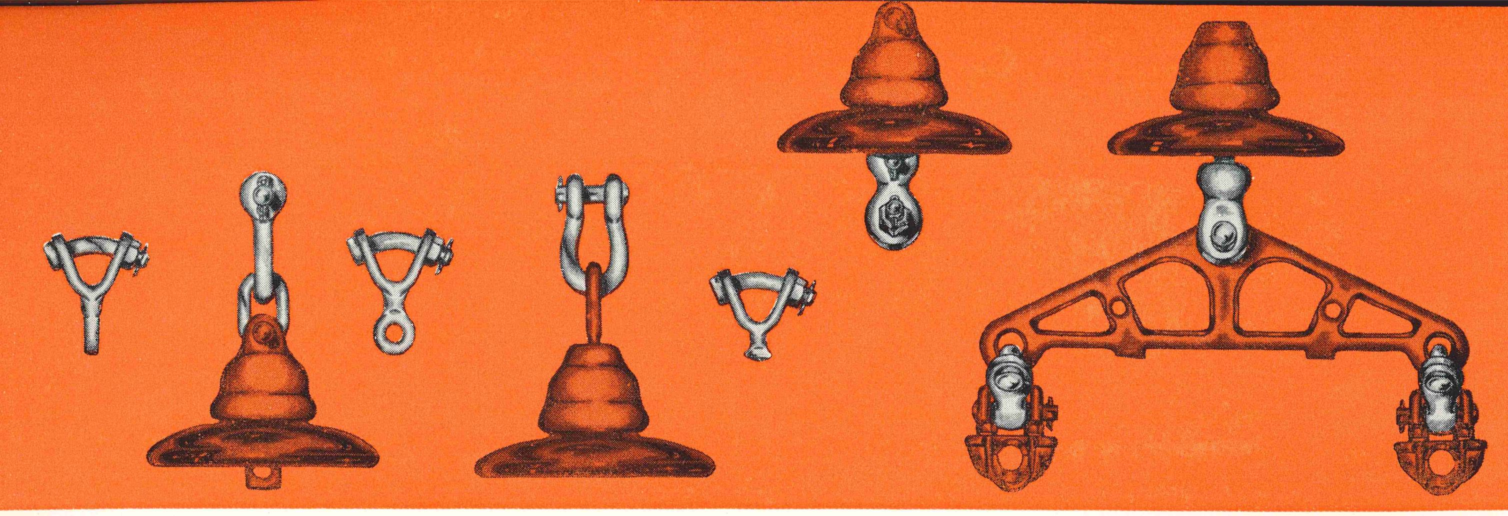
Clamps in the O-B Strateline series can be obtained to cover a range in conductor diameters of 0.15 to 1.55-inches



Universal Clamp Number 88500 holds conductor diameters of .20 inch to .50 inch. It has an ultimate strength of 10,000 pounds.

# Towers to insulators to yokes to clamps

## O-B hardware fittings keep the insulator - hardware family together



In past months, we've talked about O-B suspension insulators, stabilized yokes, and corona - control suspension clamps in our discussion of insulator hardware. These are the big items, to be sure, but what about their less glamorous brothers that hold the insulator-hardware family together?

Connecting clamps to yokes, yokes to insulators, and insulators to towers is an integral part of constructing an insulator-hardware assembly — 69 kv or 765 kv. Different design engineers approach the problem in different ways — and with different performance specifications. That's why Ohio Brass catalogs over 30 different types and strengths of connecting fittings. Each is designed to accommodate specific applications and couple compatibly with the remainder of the insulator - hardware system.

Starting at the tower top, let's see what choice we have in connecting the insulator string to the tower attachment. For a simple, one-piece connection, many design engineers prefer one of three O-B hooks. When the tower attachment furnishes a rounded load surface for the hook, a relatively flexible joint is achieved at low cost. Care should be taken when connecting a hook directly to tower steel that the surface is well chamfered, to assure mechanical flexibility. One O-B hook, Number 78420, is self-locking and cannot disconnect from the tower as long as it is assembled with the insulator.

For maximum flexibility at the tower attachment point, O-B offers several ball-eye and shackle combinations. Here, rounded surfaces complement each other and prevent binding during any mechanical cycling. Both components are forged and hot-dip galvanized. Strength ratings to 50,000 pounds let you select the right combination for your particular insulator — and with ball-socket units, with the connecting ball size.

In addition, you may select a tower attachment fitting from two ball clevises, a Y-clevis ball, two Y-clevis eyes, and four ball eyes offered by Ohio Brass. Each is designed and manufactured by O-B to work with insulators and hardware of compatible strength ratings to assure you optimum performance at the tower top. Modern manufacturing assures accurate design reproduction time after time, plus consistent high quality.

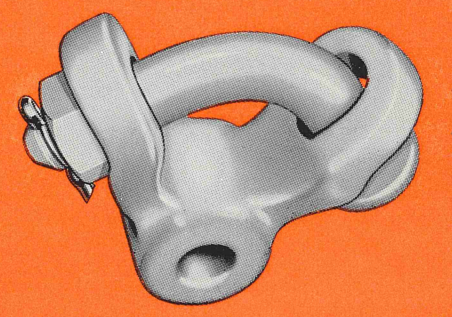
Extended striking distance without excess insulation means installation of one of O-B's numerous extension links ahead of the insulator string. You may connect the link directly to the tower or through any of the tower fittings you prefer. O-B links are available in almost any length to fit your requirements. And, you have a choice of a clevis, round-eye, oval-eye, or ball connection on either end, forged in-line or at a 90-degree angle to fit your specific requirements.

Connecting insulators to the conductor support in a single-conductor system involves the use of a clevis eye or socket-eye fitting where direct connection to the clamp is desired. In multiple-conductor systems, the insulator string will be connected to a yoke plate through a clevis Y-clevis or a socket Y-clevis. A clevis - clevis or socket-clevis fitting may also be used for this purpose, but the Y-clevis furnishes greater mechanical flexibility under dynamic conditions. O-B also recommends the use of a Y-clevis eye to connect the clamped conductors to the yoke system.

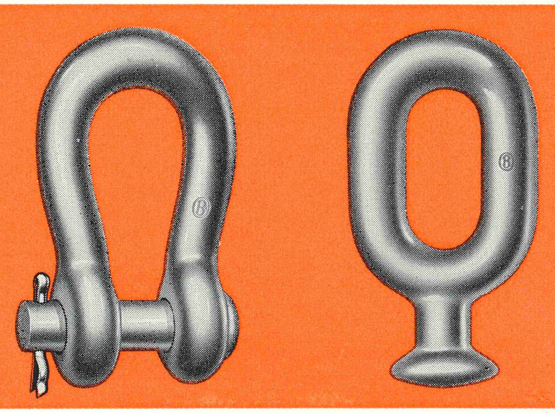
Design and manufacture of O-B's "less glamorous" hardware are just as important as those of a stabilized yoke or corona-controlled clamp. Care is taken to assure the right size metal with the correct properties is used in forging fittings that will stand up under years of rugged use and provide trouble-free service. Malleable iron hardware fittings are cast in O-B's modern, mechanized foundry, where the casting of metal is controlled to assure proper placement of strength within the fitting. Both forged and cast fittings receive a careful finishing operation to assure accurate design reproduction and compatible fit with insulators and hardware. Then, before shipment, each is hot-dip galvanized for long-lasting corrosion resistance.

When you start designing a new line, give careful consideration to the type of interconnecting hardware you use. Your O-B district manager will be glad to help, whether it's a 69-kv subtransmission line or an EHV superhighway at 765 kv. Consult pages 30 through 38 and page 47 of O-B Transmission and Distribution Hardware Catalog 44 for a comprehensive background on O-B hardware fittings. For further information, give us a call, or write: The Ohio Brass Company, 380 N. Main St., Mansfield, Ohio 44902.

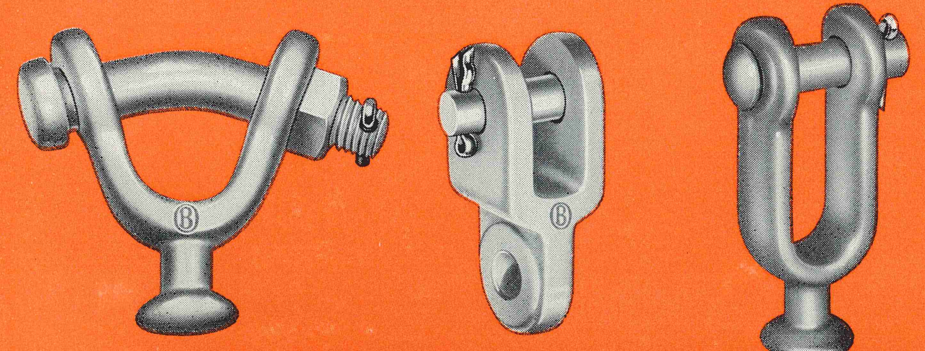
Here's one of three O-B hooks available for connecting insulators to towers. Care should be taken to provide a rounded bearing surface where the hook attaches to the tower.



O-B's Y-clevis-eye fitting gives you wrist-like flexibility at the conductor attachment point. Like all O-B fittings, it receives a coating of hot-dip galvanizing before shipment for long-lasting corrosion resistance.



For maximum flexibility, O-B recommends a shackle ball-eye combination to prevent possible binding during mechanical cycling.



Other fittings used to attach insulators to towers include the Y-clevis ball, clevis-eye, clevis-ball and fittings from O-B — each available in compatible strength ratings with O-B insulators.

**OHIO BRASS MANAGEMENT REPORT**

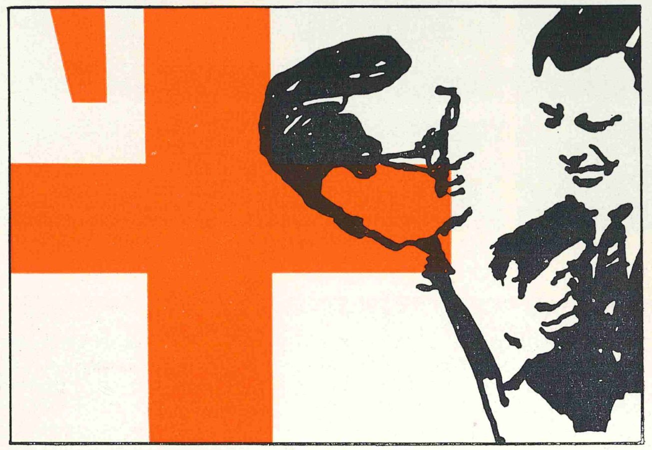
# O-B spurns "no-sell" approach; we say "accent positive"

**BY ROGER A. BLACK**
PRESIDENT, THE OHIO BRASS COMPANY

Have you noticed the trend? Companies don't hold "sales meetings," they conduct "marketing conferences." When the department store clerk ignores the money you wave at him, the manager tells you he can find customers easier than he can find clerks. It's a rare automobile salesman who leaves the sales room and goes to look for a customer. It just isn't fashionable apparently to admit you want to sell something.

**WE DON'T BELIEVE** in this approach at Ohio Brass. If I needed evidence of the difference, I saw plenty at two recent "sales meetings"—one at O-B headquarters and one at Holan Division in Cleveland. Enthusiasm ran high at both meetings over the multitude of new products. O-B announced a new station arrester that makes the advantages of EHV design features available at all voltage levels. Three other major products will be announced this year. Holan displayed two new aerial elbows, two new derricks, and a new earth borer.

**THEME FOR BOTH MEETINGS** was "accent positive," and positive it was. Besides the new products, we talked about expansion of capacity, the new computer arrangement for building inventories better suited to customer needs, an expanded service program for Holan equipment, and important new design tools at the O-B High Voltage Laboratory.



**THE REPORT WOULDN'T BE COMPLETE** if I ignored the district sales managers' complaints about insulator delivery. Believe me, you were well represented in this argument. But we did point out that the Newell plant will be going into production in mid-1967 to help ease the shortages and that we're shipping the biggest volume in history. And we didn't miss the opportunity to mention — in a positive way, of course—that many O-B products are available from stock or with a short lead time. You can include insulator-hardware, lightning arresters, bushings, potheads, and capacitors in that category.

**O-B ADMITS** it's in business to sell products. We're downright eager to sell them. The next time an O-B district manager asks for an order, please give it to him.

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Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario, Canada

OHIO BRASS

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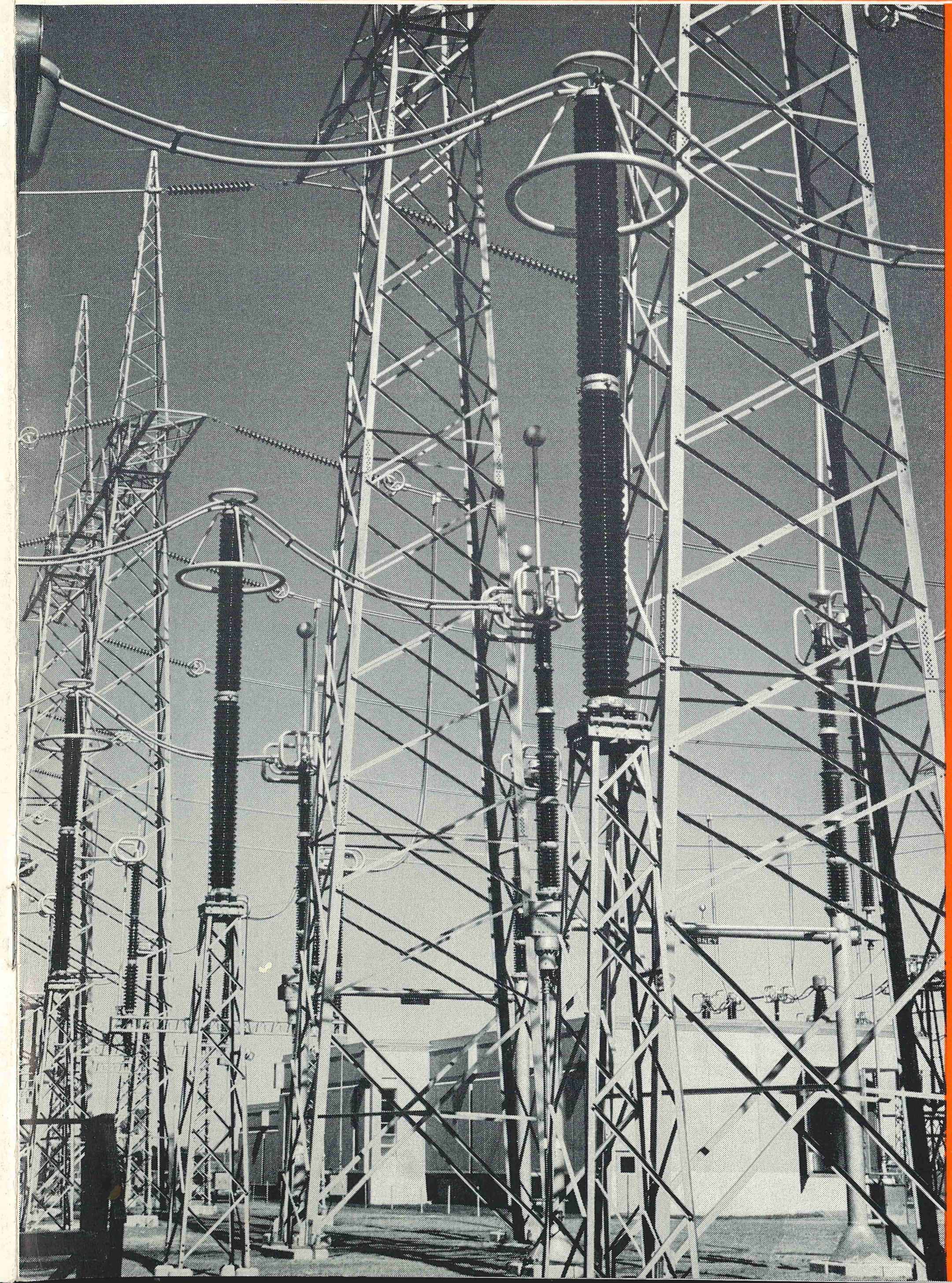
Hi-Tension News

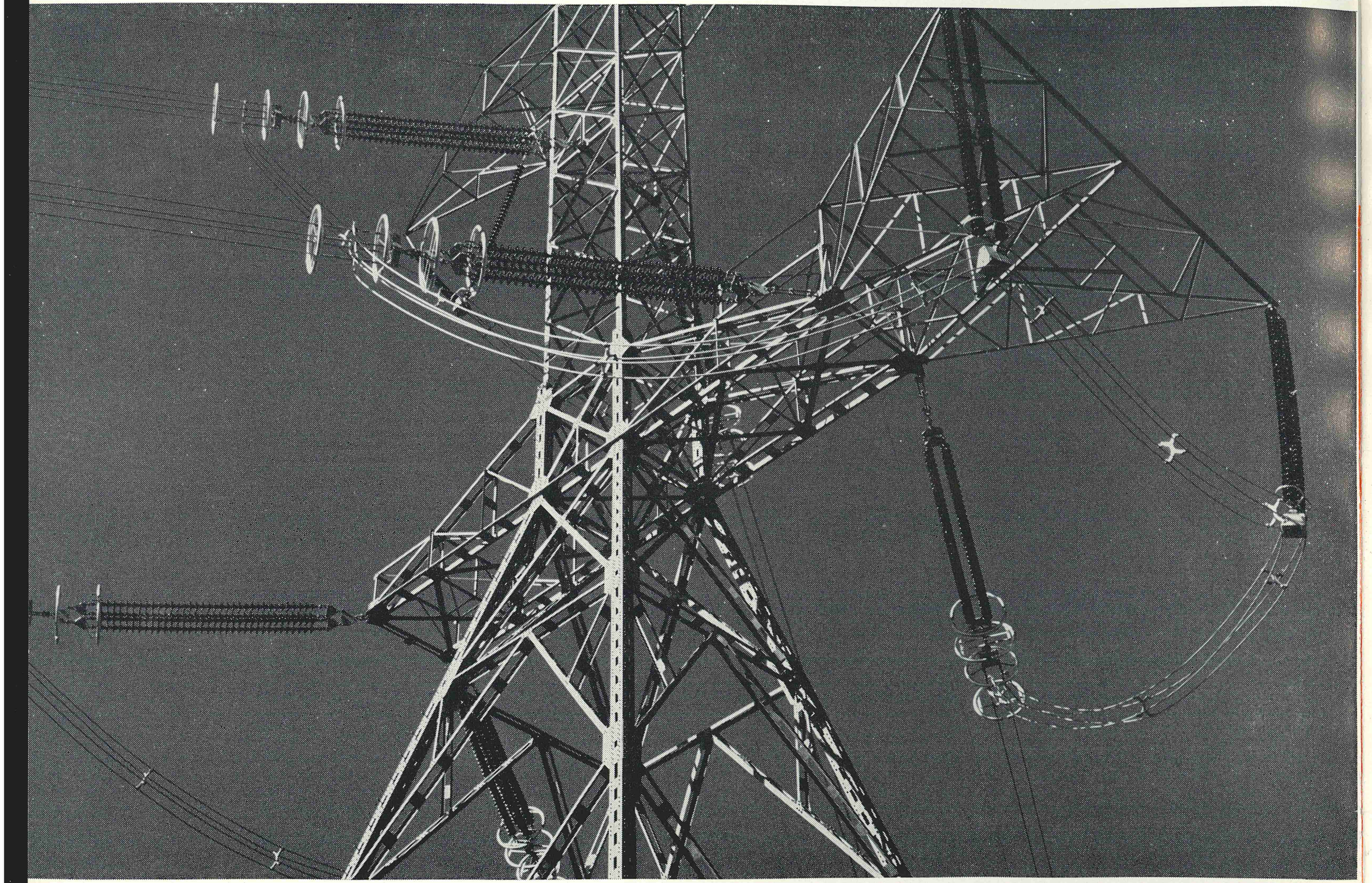
MARCH 1967



# Elaborate high-angle tower of Hydro-Quebec holds strain of four-conductor bundles unguyed

We illustrated last month the type of tower used by Hydro-Quebec for corner construction up to a 30-degree angle on its 735-kv Manic-Montreal project. Above this, and continuing to 90 degrees, a considerably more complex design is employed. Some measure of this complexity can be gained from the fact that 1,050 suspension insulator units are used to build the structure.

*(continued on page 4)*



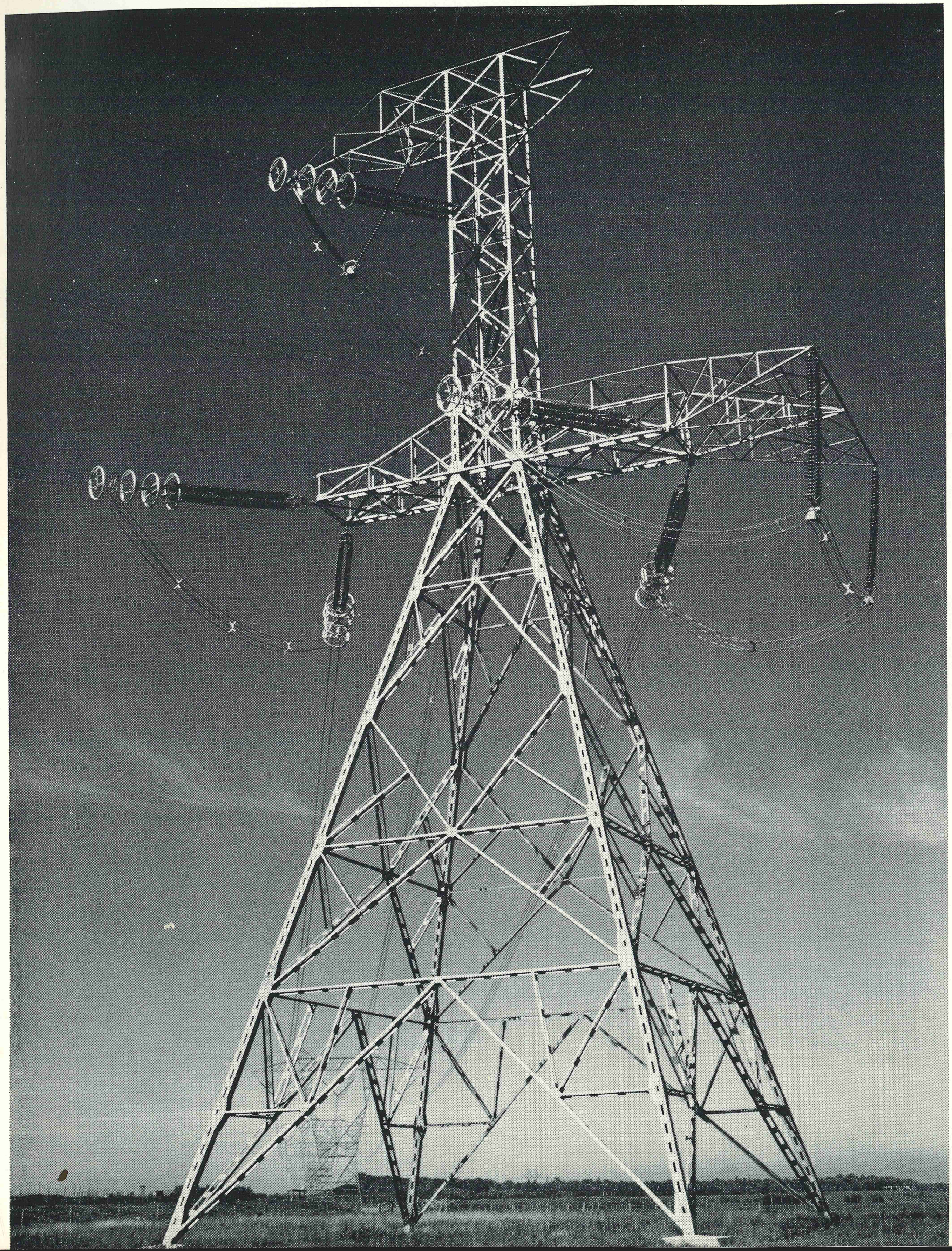
Outer phase of 90-degree tower showing complex outrigger construction of crossarm to maintain adequate electrical clearance. The standard phase spacing of 50 feet is carried through this special structure. Insulator attachments at the tower are 110 feet above ground.

OB Hi-Tension News
MAR. 1967, Vol. 36, No.3

ON THE COVER — O-B's 636-kv Dynagap EHV arresters furnish lightning and switching surge protection to huge transformers at the Boucherville Substation of Hydro-Quebec's 735-kv system.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

In spite of tremendous side strains, this high angle tower on Hydro-Quebec's 735-kv system is unguyed. Conductor anchorage is 110 feet above ground, which will provide some scale to estimate size of this structure. Note fabricated members for added strength.

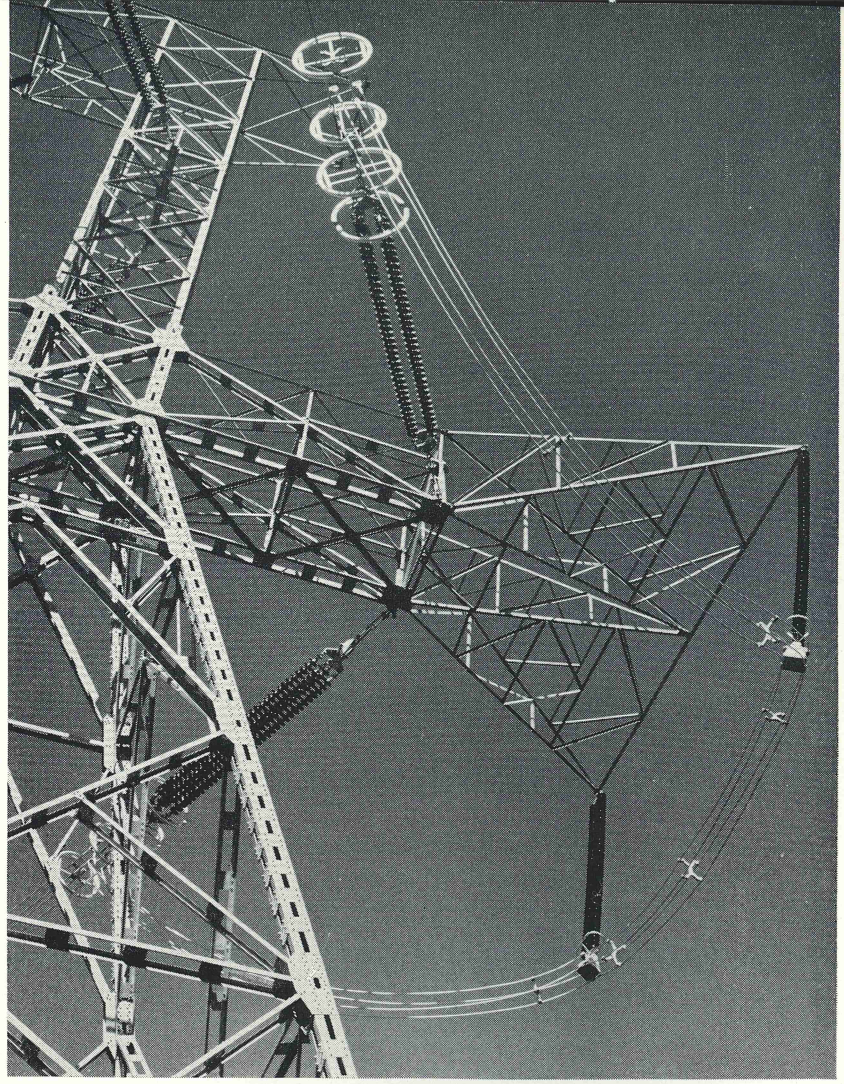


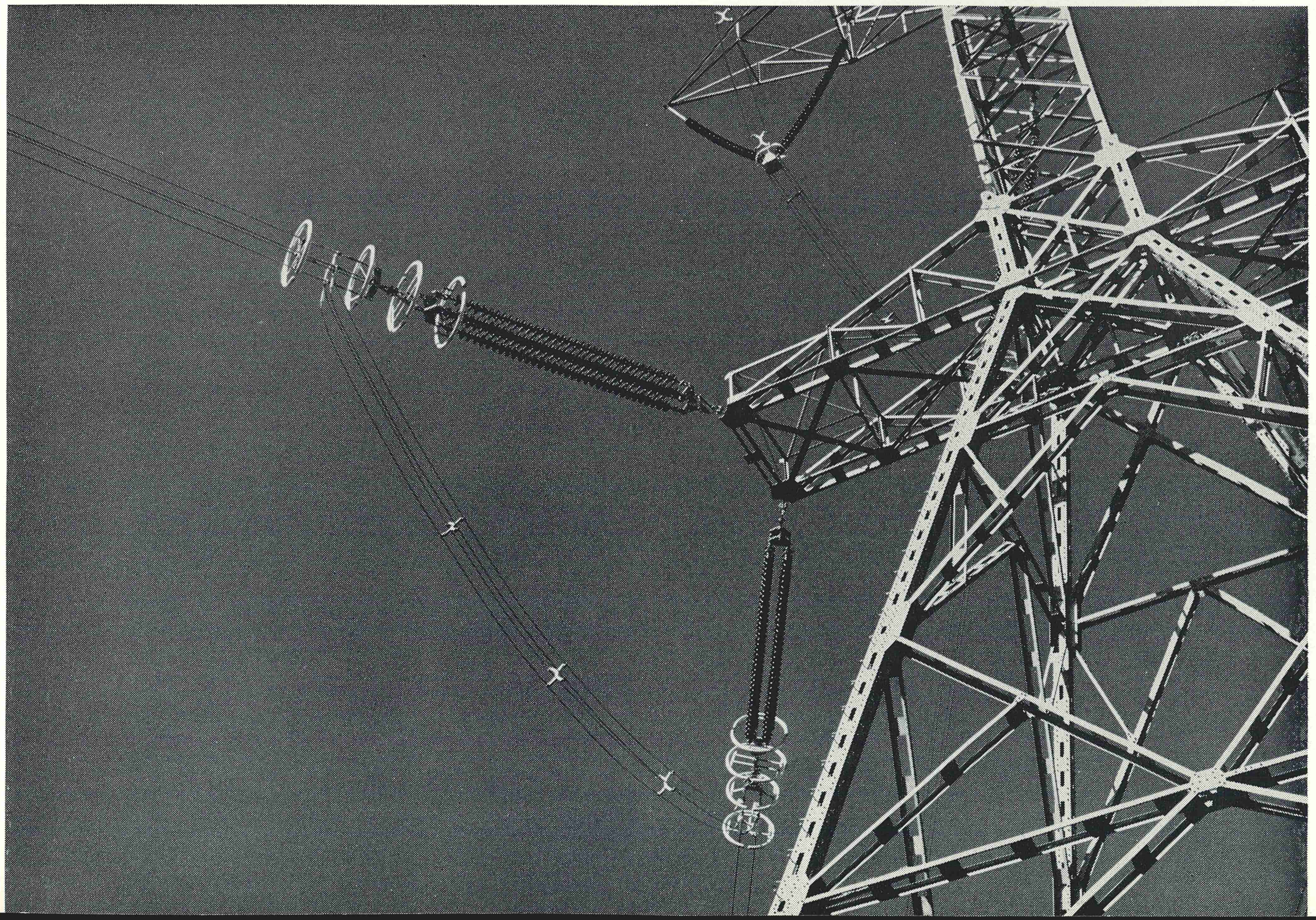
(Continued from previous page)

Comparing this tower with the previous design, it wil be noted that legs and braces are of fabricated steel. This, with its broad spread, permits the tower to support extremely heavy side loadings without resort to any form of guying.

In order to gain necessary electrical clearance for the outside phase, an elaborate crossarm extension is required to provide both distance and a long radius for the jumper connection.

On over 1,000 circuit-miles of 735-kv construction, Hydro-Quebec utilizes these high angle structures only infrequently. This is dictated not only by cost, but by the requirement for at least reasonable accessibility for heavy construction machinery. Lowest point of anchorage for insulator strings is 110 feet above ground.





Many details of the tower and insulation system are shown in these two views. Only a few towers of this class are used on the Hydro-Quebec project. These complex structures require 1,050 suspension insulators.

# What's all this talk about *Aesthetics* ?

Next to war, depression, and presidential campaigns, KEEPING AMERICA BEAUTIFUL has been a national syndrome.

*Every Litterbit Hurts* and *Smokey The Bear* have been around since shortly after Henry Ford made it possible for man to distribute his trash beyond his own backyard.

The national conscience has been consistently haunted with the thought every American is disfiguring the natural beauty of the continent and destroying its wood preserves through carelessness.

Both campaigns have been expertly and expensively handled through public affairs advertising and publicity.

Yet with all this conscientious communication, counties still employ men by the hundreds to spear candy wrappers along our highways, and Huntley - Brinkley still announce forest holocausts.

Strange as it may seem, as late as 1963, of the total land area of the United States, only 65 per cent had been topographically mapped and only 20 per cent had been geologically mapped.

In effect, we have been more concerned with the collection of waste and prevention of fire than we have been with charting our land features and determining what lies inside the land itself.

The idea of soil conservation did not occur until after the consequences of the dust bowl of the 1930's.

Attempts to correct air pollution were practically unpublicized until after the extensively discussed lung cancer research of the 1950's.

And — although meekly predicted for the last quarter of this century, only the unescapable shortage of drinking water in the northeast in the 1960's motivated the public to admit a need for action to prevent water pollution.

Yet — our land, water and air are not only *aesthetically* beautiful, but also the natural resources upon which we depend for survival.

How can a nation so ignorant of these resources suddenly substantiate the present wave of criticism of public utilities?

(Continued on next page)

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The public may decry overhead distribution of power as being "not beautiful" (a viewpoint) but they cannot deny its utilitarian value.

For the small price of a simple tangent pole and some cable, the people of the United States enjoy an unequaled wealth and security found nowhere else in the world.

While on the other hand, as they enjoy the pleasure of electric power, they consciously and/or unconsciously destroy the very natural and beautiful resources on which their future, comfort, and survival depend.

Needless to say, the solutions, now being investigated to repair and prevent further damage to our land, air. and water, would be impractical and impossible without the efficiency of electric power.

The electric utility industry has not ignored the aesthetics of our natural beauty any more or less than any other industry.

In fact there are areas of the country serviced by electric utilities which in effect deserve national praise for their individual efforts to keep pace with changing times.

For change is the challenge we are discussing here, the real challenge the electric utility industry faces.

Change is the motivator; change in viewpoint, in need, and in the technological capabilities to supply that need.

The utilities that deserve praise are those that anticipated the current change in public opinion and prepared themselves for it.

There are many.

The April, 1966, FPC Report says, "On a national basis underground lines comprise less than one per cent of the nation's transmission system. Underground transmission is an established, although comparatively limited, part of American utility systems." (1)

It lists that, ". . . 250,000 miles of overhead and underground transmission lines in this country. . . . there are 390 miles of underground transmission in New York City, 85 miles in Philadelphia, 325 miles in Chicago, 36 miles in San Francisco, and 88 miles in Los Angeles." (1) What the FPC report does not list is the per cent of URD. Some utilities have made notable achievements in this area.

The report does not mention the efforts expended to beautify overhead distribution systems and to install URD.

The following is quoted from a 1966 management syllabus of one electric utility that had recognized the impending change *early:* "Underground Distribution in residential areas is not new in our Company. The first installation was made in 1926 at Donnelly Farms Subdivision. This was a 'total underground' installation using our conventional concrete-encased duct system, conventional lead-sheath cables with the transformers and secondary connection facilities enclosed in underground vaults. The underground lines to overhead lines cost ratio was 20:1. About 1958, the demands of real estate developers in the metropolitan area, for lower-cost underground distribution resulted in the development of semi-underground system utilizing a pad-mounted transformer and above-grade pedestals with all cables in direct buried conduit. The underground lines to overhead lines ratio of this system was less than 3:1."

This company is Detroit Edison. Its history into URD, or UGD, as they call it, has already been told:

"In the years 1958 through 1961, the pace of UGD began to quicken.

"In 1958, the first underground installation was made. Detroit Edison and Michigan Bell Telephone began discussions regarding the possibilities for a joint use trench.

"1959 witnessed the issue of . . . a policy for low-voltage service connections. As a result . . . the first secondary pedestal was put into service.

"In 1960, we made our first primary - secondary and commercial installations.

"1961 saw the original task force on UGD replaced with the present UGD Coordinating Committee. The first customer metered high-rise installation was also complete in 1961.

"By 1962 UGD was moving 'full steam ahead.' The newly formed UGD Coordinating Committee, with the cooperation of the manufacturing industry, developed switching gear suitable for the Detroit Edison system.

"In 1963, Michigan Bell Telephone announced its intention to go underground with all facilities in new subdivisions by 1970. Detroit Edison drastically reduced the use of its 'duct system' and adopted a less expensive 'direct buried system' utilizing a jacketed lead-sheathed cable. Arrangements were made with the Michigan Public Service Commission to permit random lay of communication cables with secondary power cables as well as 13.2-kv grounded-wye primary cables.

"In 1964, our attention was focused on reducing the cost of a UGD system. . . . the use of concentric neutral primary cable and aluminum conductor service cable was adopted. Improved cable pole terminations, polyethylene jacketed primary cables, and precast concrete transformer pads were adopted as standards.

"Polyethylene-insulated concentric neutral cable was adopted for 65 per cent of the primary cable needs. The use of cross-linked polyethylene insulation for secondary and service cable became standard.

"After this quick resume of the developments in UGD, it soon becomes apparent that interest in UGD is rapidly expanding. In the next few years we look forward to seeing many more new developments. Developments in cable conductors and insulations are continuing and should produce new innovations such as the recently announced sodium conductor cable.

"With the perfection of a new 'load make-load break' termination it will be possible to use subsurface transformers. Studies are being made to determine the practicality of a 'total underground' system. However, like everything else, economics and feasibility will greatly influence this expansion.

On the other hand, Detroit Edison finds it practical to beautify new overhead subtransmission and distribution systems whenever and wherever undergrounding is excessively expensive or not practical.

Often they beautify the overhead perimeter leads for URD installation — in effect a combined improvement program.

These improvement efforts alone have established a mutual respect and working rapport with community leaders, often the most outspoken of critics.

They describe their beginning in this area as, ". . . slow and tedious. Satisfying individual tastes, acquiring new materials, and redesigning equipments, changing colors, varying from standards where required, etc. made quite a task out of this assignment."

They follow the "see-through" concept which satisfies both aesthetics and economics.

They are of the opinion sky-colored equipment, "improves the pole top appearance regardless of configuration."

They strive to improve the architecture of subtransmission and distribution systems in those areas where other architecture has been updated.

Experience has proved that although the theory of overhead beautification costs more in the beginning, through knowledge and planning, the cost decreases substantially in practice.

Is the industry, therefore, neglectful in maintaining pleasing and utilitarian transmission-distribution lines; equipment apropos of the architectural times?

No! The architectural fads and economies that encase people and industry are no more and no less displeasing to the eye than the equipment which distributes the power that makes them habitable and functional.

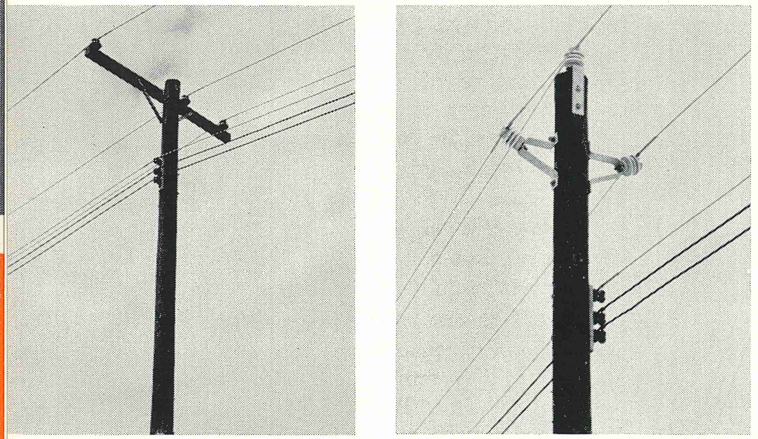
Besides, distribution equipment is replaceable in a short time at a practical cost, whereas a 20 or more story architectural blunder survives for at least half a century.

Are the solutions to present methods of overhead installation being aired, practical, or at best illogical and temporary half-measures?

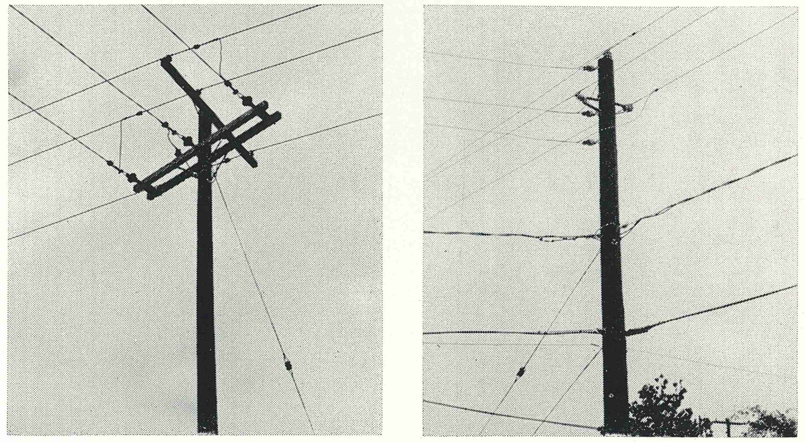
To quote Bill Shakespeare, ". . . there's the rub." What yardstick do we use to measure that which should replace the unwanted? The public's whim? Or can we turn to technology?

The turn to technology will be the subject of the third article of this series.

(1) *Underground Power Transmission. A report to the Federal Power Commission by the Commission's Advisory Committee on Underground Transmission, April 1966.*



A



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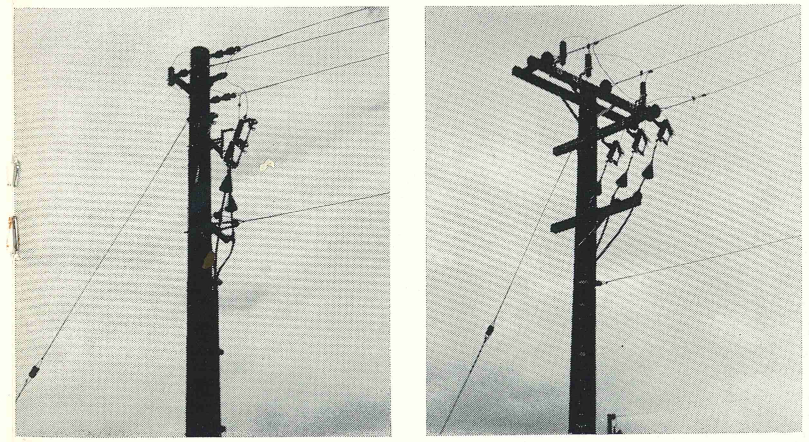


C

A. The crossarm is removed and the total silhouette reduced for a more pleasing over-all appearance.

B. Compare the "L" corner on the right to the regular corner installation.

C. The photo on the right is a typical primary-customer cable pole on a flat circuit line. In the photo on the left the appearance has been improved and the cost reduced by the slim-silhouette design.

# Dynagap 5's major increase in durability meets industry's growing need for arresters with high energy discharge capabilities

What are the changing conditions in the utility industry which accent the advantages of arresters with increased durability? What yardstick is available to compare the durability characteristics of modern arresters? Are today's arresters keeping pace with industry's requirements for increased durability?

In discussing the first question, we need only review and recognize the growth pattern of the electric utility services during the past decade. Loads have increased tremendously, requiring new or rebuilt lines with adequate capacity. System reliability has acquired new emphasis, especially as a benefit of the broad move toward interconnected companies. Arrester applications are more numerous, are better engineered for existing conditions, and give greater protection through improved capabilities.

Unquestionably, the major factor involved in upgrading arrester durability to match changing system requirements is the rapid and universal trend toward increased system voltages. Discharge capabilities of arresters must be increased as voltages increase and, when EHV levels are reached, are usually the most critical factor in arrester application. Stored energy is a cumulative quantity and varies as the square of the voltage and increases proportionally with longer lines and additional capacitor banks. Closer protective levels have resulted in significantly more severe arrester duty, with more frequent and often closely spaced operations.

Historically, the measure of an arrester's durability has been the low-current, long-duration test. The validity of this test has become more and more open to question because of changes in fundamental arrester operation and the difficulty in correlating the test with actual system conditions.

The low-current, long-duration test is not necessarily conducted on a complete arrester or a complete prorated assembly. It is basically a current-defined test which essentially determines valve block capability and obviously does not include the influence of the modern current-limiting gap concept. Furthermore, the square impulse wave form of the test current discharge bears little resemblence to the vast variety of energy discharges of the typical high-capacity transmission lines.

These, then, were the conditions under which a group of engineers working under the auspices of NEMA proposed a new definition for a suitable test for arresters in respect to the discharge of stored transmission-line energy. Recommendations were published in IEEE Paper 64-143 and the procedures have since been recognized in NEMA Standards LA-1-1965.

The most significant departure from the former test procedure was the specification that the test be conducted on arrester sections including both block and gap elements which should be allowed to operate as a function of their design, whereby resistance characteristics and gap structure become an integral part of the discharge test.

Figure 1 — Photograph shows a portion of capacitive and inductive component bank of the adjustable long-duration, surge-current generator used to match transmission line energy discharges.

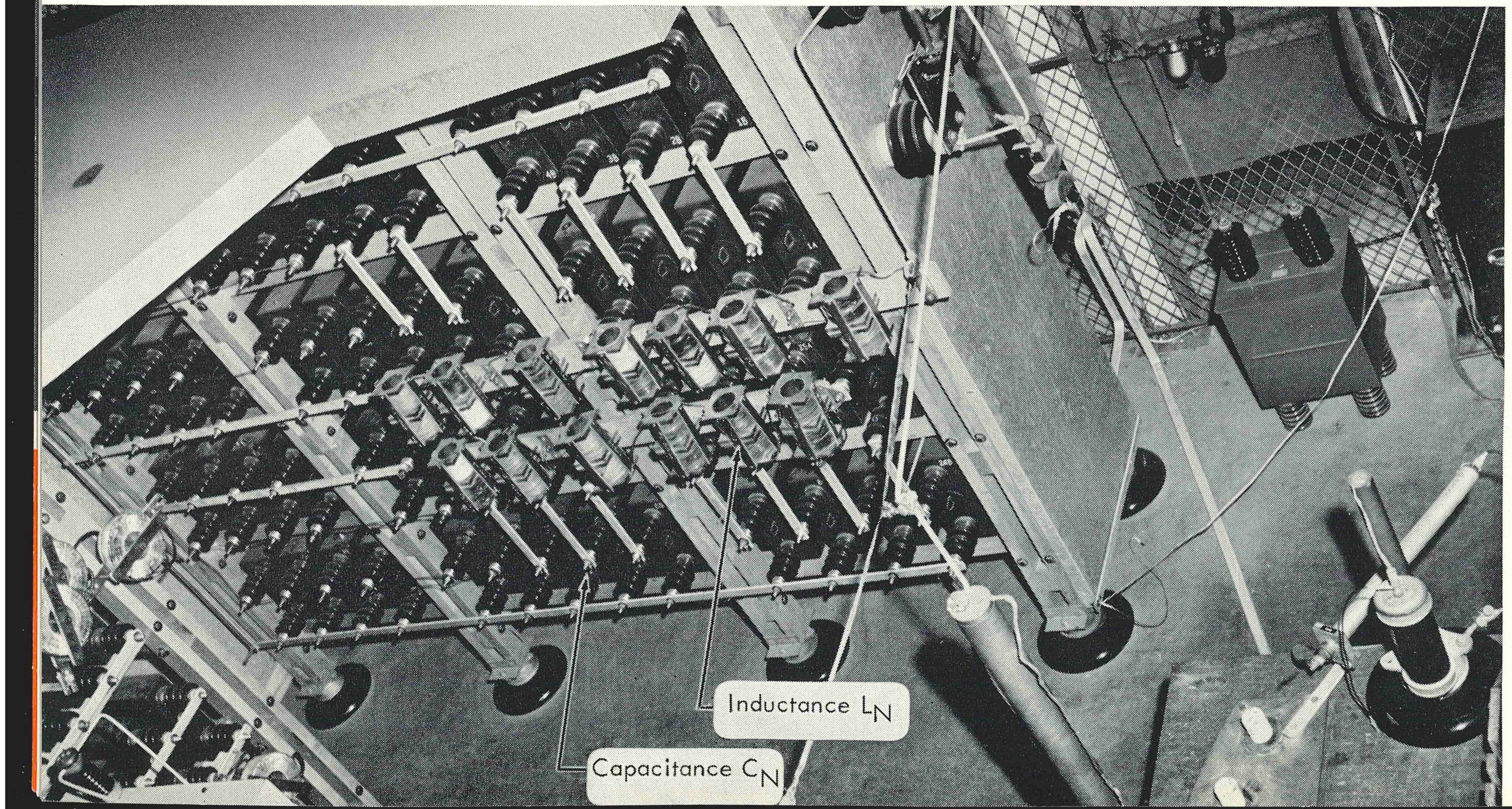
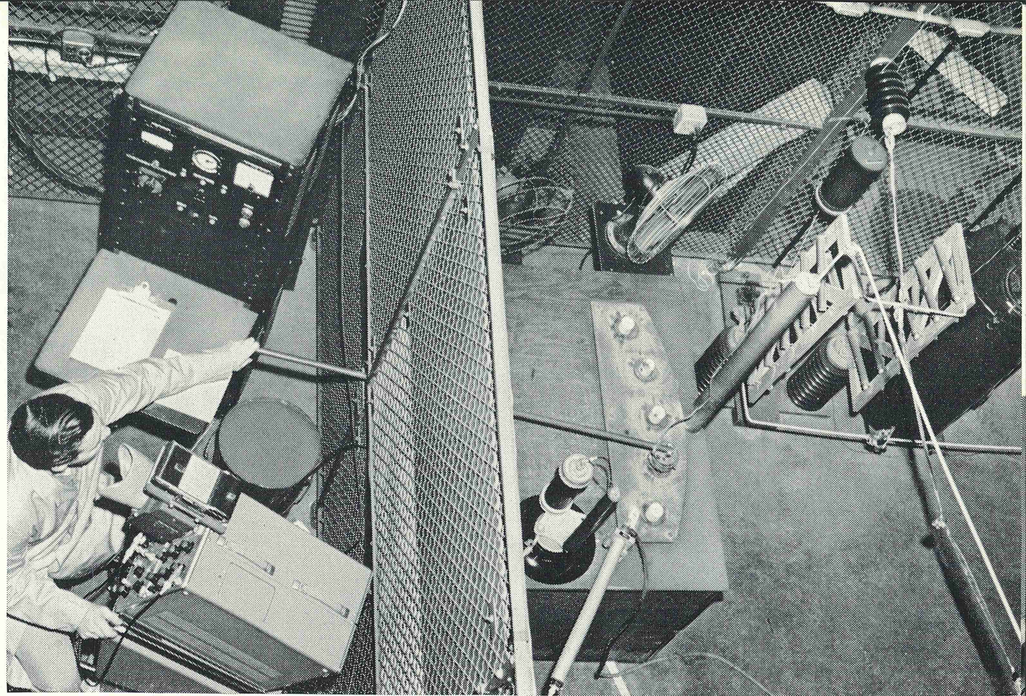



Figure 2 — Energy discharge testing on prorated arrester sections is recorded photographically in order to determine the maximum per unit charge which can be handled repetitively under the specified conditions.



The test then defined the form and origin of the energy discharge. The recommended procedure outlines the method by which the line charge voltage and surge impedance are reduced in direct proportion to the prorated arrester specimen, while the reactance (L-C product) of the line is maintained at full value in order to obtain a surge duration corresponding to service conditions.

O-B's special long-duration current-surge generator, which was constructed to provide energy-discharge testing, is illustrated in Figure 1. The basic schematic diagram of the circuit by which the generator can produce electrical characteristics corresponding to specified transmission lines is shown in Figure 3. The range of adjustments of the inductive and capacitive components permits accurate impedance matching to a wide variation of specified line values for actual transmission systems.

The laboratory tests are arranged to simulate the most severe energy discharges to which the arrester can be subjected under the prescribed conditions. The capacity of O-B's long-duration current generator is ample to store and release energy discharges exceeding those of the longest and highest voltage transmission lines and cables now being considered.

With the specified length of line and surge impedance remaining constant, values obtained from the surge generator tests are given in the form of maximum allowable per unit system charges (based on 1.05 x nominal system voltage) and are tabulated for each arrester rating in the group under consideration. System analyzer studies are conducted using proposed parameters to determine maximum anticipated per unit system charges and by correlation the protective level for the system can be determined. The importance of arrester durability in respect to maintaining the necessary protective margins cannot be overemphasized, since the economic rewards involved in reduced equipment insulation levels have become a most significant factor in system planning.

Dynagap 5 arresters are the answer to the final question regarding the need for greater durability. Modifications of the current-limiting gap have produced so substantial an increase in the discharge capabilities that Dynagap 5 arresters easily meet the most severe requirements of any modern transmission system. Most realistic measure of their capabilities is in the tabulation of per unit charge voltages for typical 345- and 500-kv systems:

| Per Unit System Charge* | Line Length (Miles) | Nominal System Kv | Arrester Rating (Kv) | Line Surge Impedance (Ohms) |
|---|---|---|---|---|
| 2.65 | 300 | 345 | 258 | 325 |
| 2.70 | 300 | 345 | 264 | 325 |
| 2.85 | 300 | 345 | 276 | 325 |
| 3.10 | 300 | 345 | 300 | 325 |
| 2.47 | 250 | 500 | 396 | 300 |
| 2.62 | 250 | 500 | 420 | 300 |
| 2.77 | 250 | 500 | 444 | 300 |
| 2.92 | 250 | 500 | 468 | 300 |

* Based on 1.05 x nominal system voltage

Dynagap 5's exceptional superiority over any other station-class arrester is sharply defined when compared on the basis of industry's most important consideration — the inherent durability characteristics of the arrester.

Figure 3 — Circuit diagram for surge generator used in transmission line discharge tests.

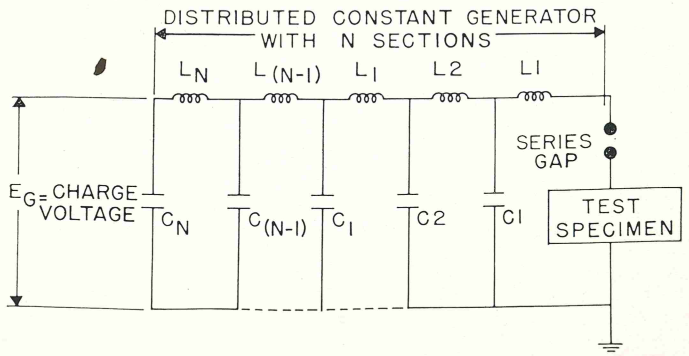
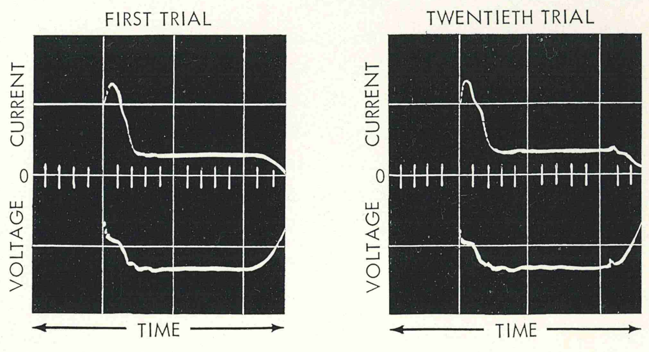
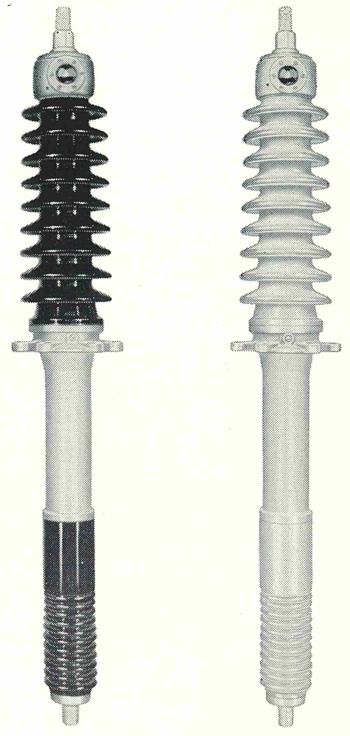



Figure 4 — Typical oscillograms produced in transmission line discharge testing of O-B's new Dynagap 5 station class arrester.





O-B GK-30 Breaker-Tran Bushings.

# Revised standards for bushing terminals increase Breaker-Tran interchangeability

## Universal terminal on O-B's Breaker-Tran bushings satisfies both fixed-conductor and draw-lead installations

Terminal design changes incorporated into O-B's Breaker-Tran bushings (15-through 69-kv insulation classes) extend the interchangeability advantages permitted by ASA Standards C76.1 - 1964, table 7.1 (a). The universal upper terminal now furnished on GK-10 through GK - 30 Breaker - Tran bushings enables their use without modification for 1200-ampere circuit breakers or 1200-ampere fixed-conductor and 400-ampere draw-lead transformer applications.

Before the revised standards became effective, it was necessary that two different terminal assemblies be available for the otherwise completely interchangeable bushings in order to meet all installation requirements. The former arrangement specified that upper bushing terminal for the 400-ampere draw-lead application have 1-⅛" - 12 threads, while the terminals for 1200-ampere fixed-conductor application have 1-½"-12 threads.

In accordance with this requirement, O-B's Breaker-Tran bushings have been supplied up to the present time with the option of 1-⅛- or 1-½-inch threaded upper terminal. The 1-⅛-inch threaded terminal included either a spade- or crimp-type inner terminal for draw-lead connection, while the 1-½ - inch threaded terminal was a one-piece unit which screwed on the upper end of the central conductor or bolted solidly to the flange of the reservoir cover.

The change in the ASA Standards revised the specifications for the draw-lead terminal to provide the same 1-½-inch outer threads as the fixed-conductor terminal. Under such conditions, complete interchangeability of the Breaker-Tran bushings has been achieved by introducing a universal upper terminal which incorporates into a single assembly all provisions for both draw-lead and fixed-conductor installations.

The inner draw - lead terminal furnished with the universal terminal assembly may be either of the spade or crimp type. Customary practice when using the spade-type terminal is to divide the stranded lead wire and braze equal portions on either side of the flat surface. Crimp-type terminals are normally assembled to the lead wire by a pressure fit.

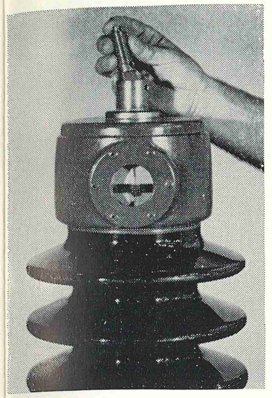
In cases where the draw-lead-type connection is considered an unnecessary option, the universal terminal is available without inner terminal components, thus eliminating unneeded parts, but retaining full interchangeability among fixed-conductor installations.

Design of the Breaker-Tran bushings permits the oil level for transformer service to be anywhere from the bushing flange to about five inches below the ground sleeve. Under such conditions, this single bushing can often be used in place of standard 10-, 16-½-, and 21-inch-oil-level transformer bushings. Breaker-Trans cover not only "Table 7.1 (a)" conditions, but can be used without modification in three "Table 7.1 (b)" categories: 400-ampere draw-lead 16-½-inch oil level; 400-ampere draw-lead 21-inch oil level; and 1200-ampere, fixed-conductor 21-inch oil level.

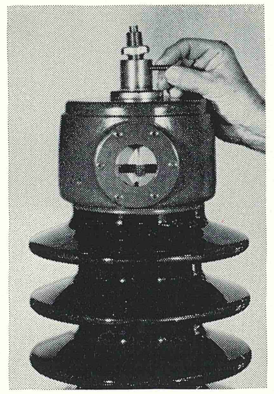
No conversion of the bottom terminal of the Breaker-Tran is necessary between draw - lead and fixed-conductor applications. The central conductor extends several inches below the lower end cap and can be used for attachment of circuit-breaker parts or fixed - conductor connector in transformers. The conductor is a rigid copper tube with ⅞-inch-inside-diameter opening for draw-lead applications.



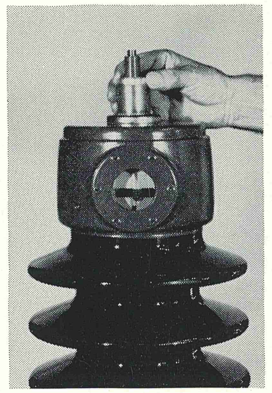
Transformer draw lead is first attached to inner terminal. Spade - type terminal is shown, but crimp-type is available.



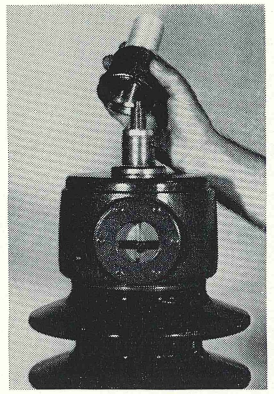
Inner draw-lead terminal is then pinned in its proper location in respect to the bushing conductor tube.



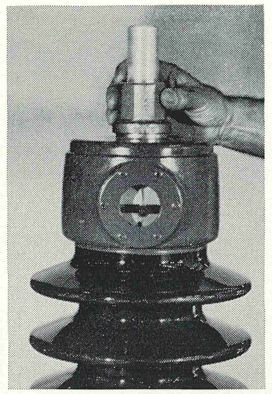
Tightening the locking nut on the inner terminal which is pinned in position, assures positive pressure-current junction.



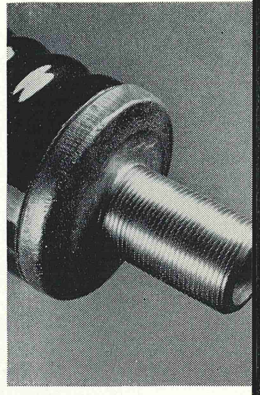
With the "O" ring gasket fitted in its groove, the outer terminal is screwed onto the threaded conductor tube.



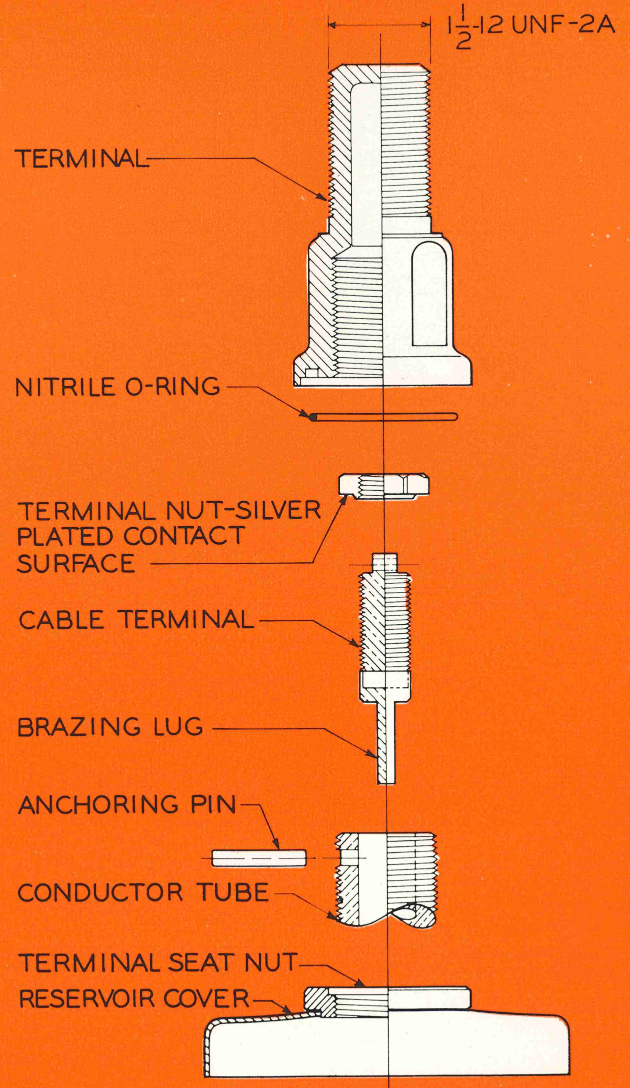
Completed terminal with 1-½" - 12 threads is identical for both fixed-conductor and new draw-lead installations.



Lower end of Breaker-Tran can be used for either fixed conductor or draw-lead installations without alteration of any kind.



The current path through the new universal draw-lead terminal is indicated in this diagram by colored arrows. All junctions between the assembled parts are under positive pressure assured by threaded mating surfaces.




Relationship of parts in O-B's new universal terminal assembly furnished on Breaker-Tran bushings (GK-10 through GK-30).

**OHIO BRASS MANAGEMENT REPORT**

# A third partner is ready to supply ideas for railway electrification

**BY ROGER A. BLACK**
PRESIDENT, THE OHIO BRASS COMPANY

To keep its image modern and shiny, the company that spends considerable time developing and testing products for 700-thousand-volt and higher transmission lines should seldom refer to its origins . . . especially if it originated as a manufacturer of harness buckles and other "mule jewelry."

**THE REFERENCE WOULD BE,** however, a quick way to remind our friends in electric power companies that Ohio Brass started almost 80 years ago as a supplier to the transportation business when the horse was in his prime. As the kilowatt replaced four-legged horsepower, we began making electrical equipment for both urban and interurban transportation.

**YOU'LL FIND O-B INSULATORS** and catenary fittings on practically every section of electrified railroad in the United States. Unfortunately (from our viewpoint and perhaps from yours), only slightly more than one per cent of the railroad miles are electrified.

For the past quarter century, we have been long on electrification ideas but short on places to put them to work. Now we see several reasons to expect a revival in railway electrification:

**1.** As the airports move farther from downtown, fast land transportation looks like the best solution to mass transportation for distances up to 500 miles when total travel time is considered.

**2.** At the 160-mile-per-hour speeds proposed for passenger and freight service, the electric motor looks like the most practical power source.

**3.** In congested areas, some of the best right-of-way for transmission lines lies over the railroads. *Electrical World* recently reported that nine railroads and 12 utilities now share 500 miles of right-of-way in Northeast states.

**YOU PROBABLY KNOW** many more good reasons for revived interest in railway electrification. If your company is contemplating partnership with a railroad on an electrification project, please consider including Ohio Brass as a third partner in making your plans. We have a whole bag of ideas—some proved, many new—that we would be glad to make available to you.

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OHIO BRASS

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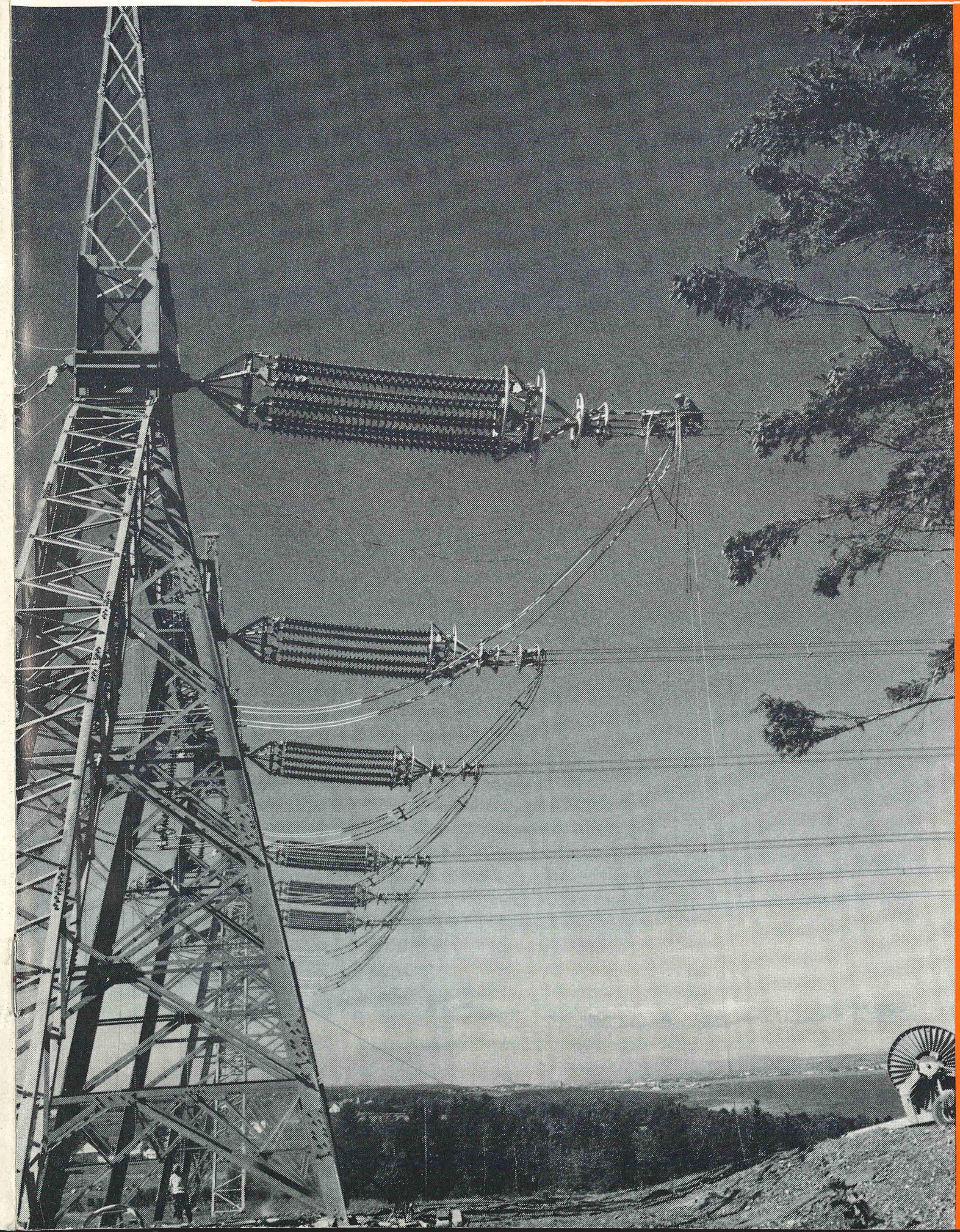
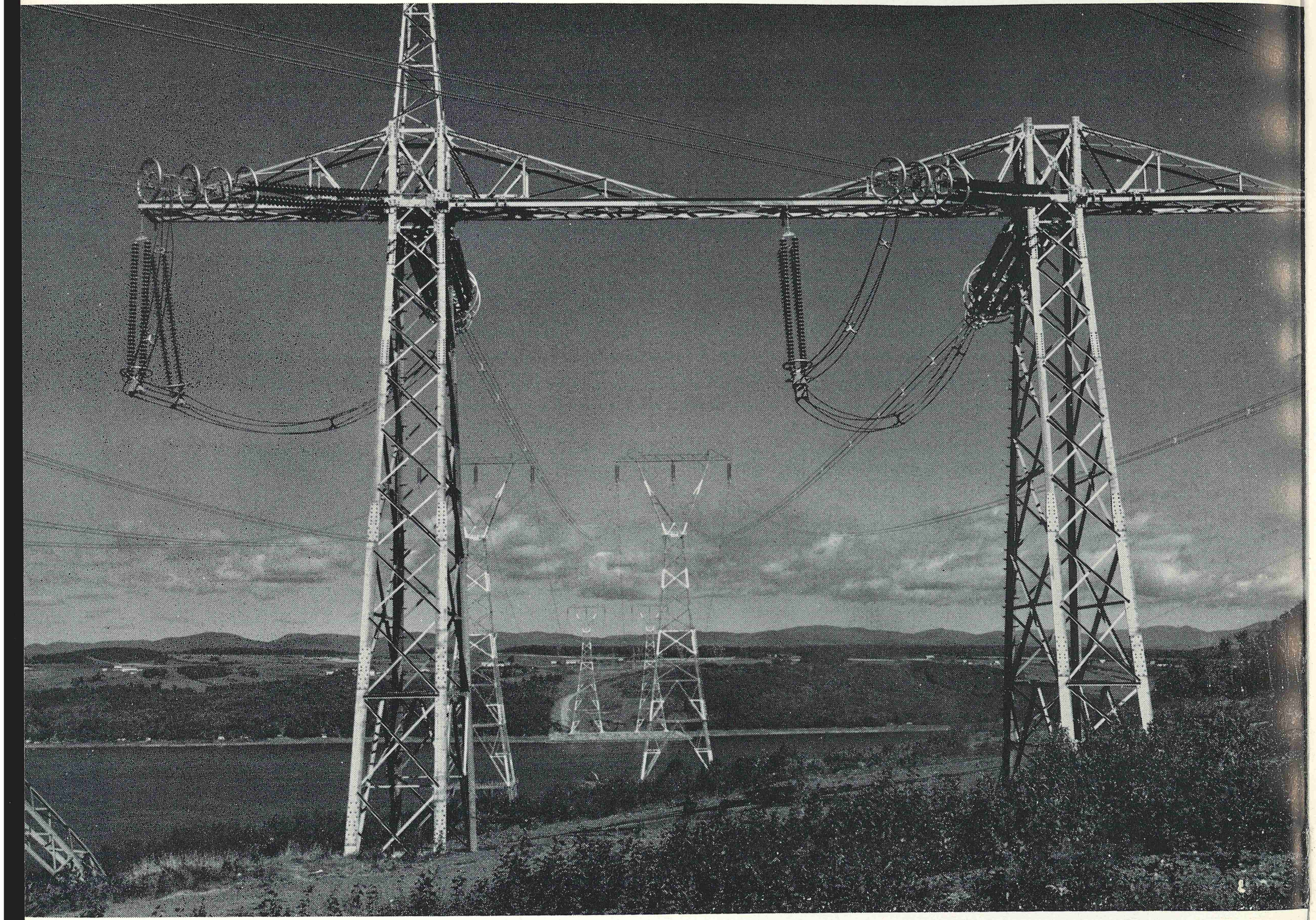
# Hi-Tension News

APRIL 1967



# Biggest piece of biggest transmission line . . . Hydro-Quebec's St. Lawrence River crossing

View through an anchor tower toward the suspension towers and across the St. Lawrence River. Main span over the river is 5,200 feet. Back spans between suspension and anchor towers are 2,200 feet and 2,400 feet, respectively, totaling 9,800 feet between deadends.



Hi-Tension News
APR. 1967, Vol. 36, No. 4

**ON THE COVER:** Completing the last jumper loop on the spectacular St. Lawrence River crossing of Hydro-Quebec's 735-kv project.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

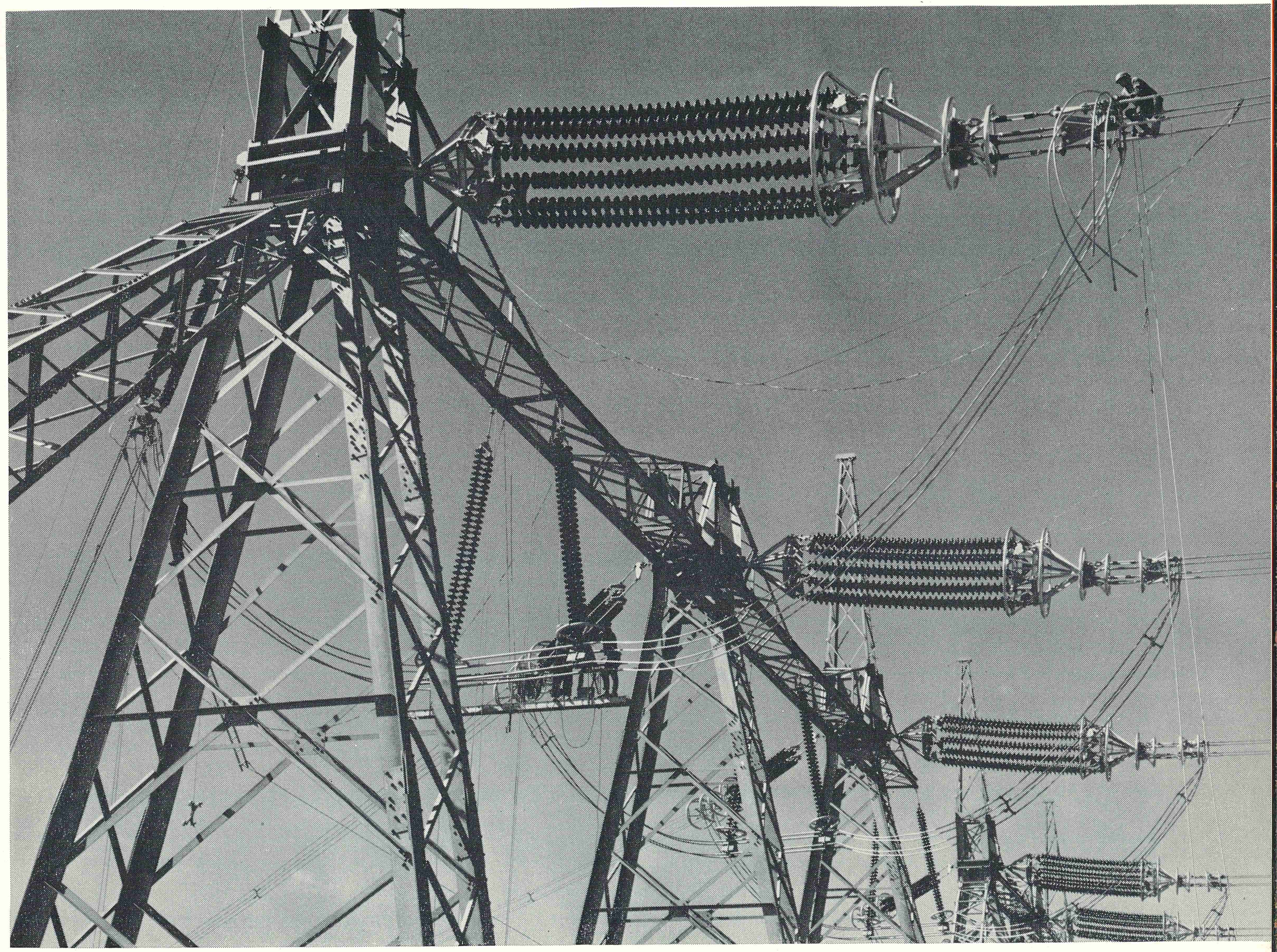
To climax the series of pictures we have shown over the past three months, we now will look at the biggest piece of construction on the biggest transmission line now operating . . . where two four-bundle circuits cross the St. Lawrence River on Hydro-Quebec's 735-kv system. These must provide clearance for deep water navigation without the benefit of appreciably high land on either river bank. There are other major river crossings on the project, but this one is the most spectacular, due to the combination of relatively flat terrain, high clearance requirements, and length of span.

Crossings consist of three spans; the main center span of 5,200 feet over the river, supported by two suspension towers, and two back spans 2,400 feet and 2,200 feet in length, deadended on relatively short, stiff, unguyed anchor towers. These towers are located on the hillsides approximately 300 feet above normal water level.

To obtain the required clearance over a waterway used by ocean shipping, two man-made islands were built a considerable distance out into the river. Two 552-foot suspension towers were erected on each island; each tower supporting a separate circuit. The construction of these islands and their towers represented the most economic solution to the crossing problem,

*(Continued on next page)*

Last jumper loop in progress of construction. Men in the picture provide some scale for measuring the massiveness of these deadends. Each assembly has an M&E rating of 600,000 pounds. Estimated maximum loading per phase, assuming 1½ inches of ice, is 260,000 pounds.



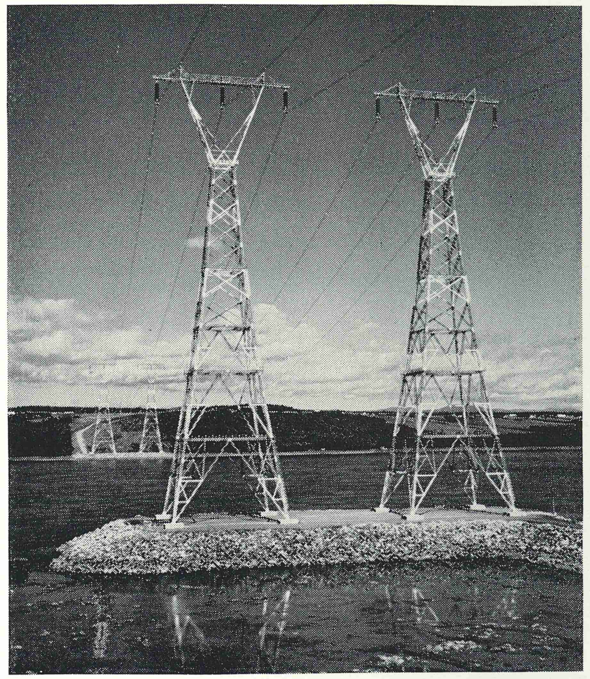
*(continued from previous page)*
as towers erected on the river banks would have been much higher and more expensive to maintain the necessary clearance at mid-span.

Each phase of the crossing is a four conductor bundle spaced on an 18-inch square. Subconductors are a special alloy aluminum cable, steel reinforced, consisting of a single layer of 23 aluminum alloy strands over a 37-strand steel core. The conductor has a minimum ultimate tensile strength of 107,500 pounds and a diameter of 1.1 inches.

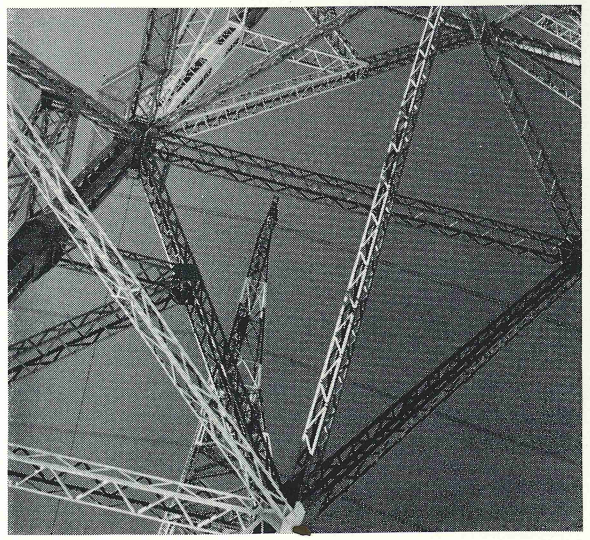
Anchor towers are relatively short, stiff structures with a strut at one end to take lateral loads. Class C design loading per phase is 190,000 pounds, and loading with 1½ inches ice, no wind, is 260,000 pounds. The insulated deadend assemblies consist of 12 strings of 34 clevis-type suspension insulators, having M&E ratings of 50,000 pounds, supplied by Canadian Ohio Brass Company. Through a load-dividing arrangement, strain is completely equalized over the 12 strings. Mechanical failure of a single string will add less than 10 per cent load increase on the remaining strings. The assembly was designed by a specialist group consisting of a Hydro-Quebec project engineer, and engineers from the structural consultants, cable supplier, and Canadian Ohio Brass Company. The basic design is the same as that used on the 12-string Kootenay Lake Crossing in British Columbia supplied by C-O-B in 1953. Each deadend assembly, complete with insulators and control rings, weighs 16,400 pounds, of which 10,000 pounds represents the insulators.

Pictures shown here were taken on the south bank in September, 1966. One circuit is energized, and the second circuit is being completed by the installation of the last jumper loop. It is interesting to note the relative size of men in various views . . . it gives some scale to the construction. One photograph was made looking up through a pair of the river-crossing towers to show better detail of metal fabrication.

While at times the work appears complicated, construction crews quickly became adept at handling the four phase conductors used throughout the Hydro - Quebec transmission system. It has been well proved out that quadruple bundles present no insurmountable problems in building a line.



Man - made islands built well out into the river support the 552-foot suspension structures holding the main span of 5,200 feet. This type of construction proved to be the most economic method of maintaining navigation clearances in an area where no high land was available for anchor towers.



Details of steel fabrication are well illustrated in this view looking up through the framework of one suspension tower to the top of its companion 552 feet above ground. These towers support the dead weight of the conductors, only. All strains are taken at the deadend positions.



# Holan combines versatility and economy in light-duty Bronco 87

Compact. Agile. Versatile. Safe. Economical. Each adjective fits Holan's new Bronco 87. Just introduced, the new 87 offers you something new — a choice in design that's sure to adapt to your equipment needs. Whether it's streetlight maintenance, insulator replacement, or phase relocation, there's a Bronco 87 tailored just for you.

A quick look at the specifications reveals a choice between two bucket heights — 27 or 31 feet. Continuous 360-degree superstructure rotation is standard. The Bronco 87 offers a man-and-tool-load lifting capacity of 300 pounds anywhere in the flight pattern. Uniform-stress upper and lower arms give operating personnel safety and solid confidence when working overhead. Upper-arm travel is a full 125 degrees relative to the lower arm which pivots 95 degrees from the horizontal.

A strong base frame and integral torsion bar stabilizer add further stability and safety to the Bronco 87. Outriggers do not have to be set on the Bronco 87, so work may be performed faster after arrive at the job site. All elbow functions are controlled either from the bucket or chassis levels by two metering, high-pressure hydraulic control valves. Each valve is equipped with fail-safe, spring-centering spools and connected in a series-parallel arrangement. And, a safety selector and override control for the hydraulic system are standard.

Take a look at the broad choice you have only with the Bronco 87.

For tree trimming and streetlight maintenance, the Bronco 87-27-1 or 87-31-1 fills the bill. Both are all-steel units with rectangular cross-section steel upper and lower arms. An open, steel bucket completes the package in this one-man aerial lift. The Bronco 87-27-1 stands as Holan's lowest - priced articulated arm aerial device — and just a short step up from an aerial ladder.

If your primary job requirements are for an elbow to work on distribution circuits, a new Bronco 87-27-2 or 87-31-2 fits right in. With a steel lower arm, each unit is equipped with an all fiberglass-reinforced plastic upper arm and a fiberglass bucket. The upper is fully insulated and electrically tested to 100 kv ac, minimum.

Where cross phasing and ground personnel protection are desired, you need the Bronco 87-27-3 or 87-31-3. With either of these units, a fiberglass-reinforced plastic upper arm and a lower arm insert are standard. A fiberglass bucket is recommended to round out the unit, giving you the capability to handle transformer re-fusing or higher voltage distribution circuit maintenance in complete safety and confidence.

Whether you select the model 27 or 31 in any of the three available variations, traditional Holan quality is standard. Hydraulic system capacities of up to six gallons per minute are available, with cylinder pressures up to 2200 pounds per square inch. Each unit is available with an SAE power take-off or optional engine and gear - type pump. And, all Bronco 87 units are tested at 1½ times rated load for both structure and stability performance before shipment, to insure product integrity.

Built-in reliability for assured low maintenance results from the care taken by the men who design, build, and inspect your Bronco 87. They're skilled personnel who are never satisfied with second best. Holan backs their work — your Bronco 87 — with a clear-cut one-year warranty.

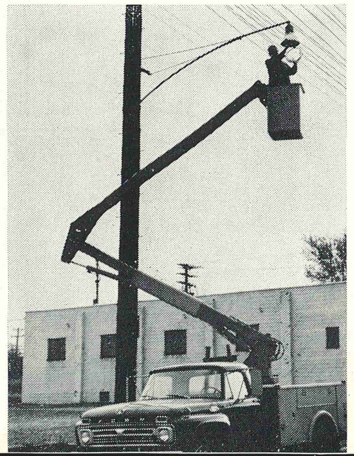
Options for the Bronco 87 consist of several groups and invidual features. A safety group incorporating an engine start, stop, and buzzer is available — bucket mounted with push-button operation. Manually actuated brake locks, an emergency power pack, safety interlocks to prevent truck movement unless the elbow is stored, and an intercom system are also included on the list of options.

Suggested mounting vehicles for your Bronco 87 include a minimum 10,000- and 15,000-pound gross vehicle weight units for the 27- and 31-foot elbows respectively. Recommended minimum cab - axle (CA) dimension is 60 inches. Compatible Holan Pack Horse bodies for the Bronco 87 units include the TA-102 and CA-102 designs.

Before you specify a ladder truck replacement, check with your Holan representative. He'll be glad to show you how to give your crews the flexibility of a fully articulated aerial elbow at near-ladder prices. Just give him a call.

◀ Here's Holan's lowest priced articulating arm aerial device mounted on a one-ton vehicle — the all-steel Bronco 87-27-1. Upper arm travel is 125 degrees relative to the lower arm which pivots 95 degrees from the horizontal. This all-steel model provides easy bucket entry from body load space.

At the top of the Bronco 87 line, Holan offers a fiberglass-reinforced plastic upper arm, fiberglass insert in the lower arm, and a fiberglass bucket. A complete line of options, including a cable-splicer's bucket, lets you tailor your Bronco 87 — 27- or 31-foot model — to your specific job requirements. ▶



# O-B's capacitance-graded potheads establish uniformity of voltage gradients comparable to other system insulation

Terminations of an underground transmission cable pose problems in the control of voltage stress quite different from any other existing on electric utility systems, yet the solution has remarkable similarities to other insulating practices. Figures 1 and 2 compare the application of fundamental principles in relieving voltage stresses in the installation of a capacitance-graded pothead with that of line insulators and apparatus bushings, respectively.

Major difference in terminating the underground cable is a consequence of the inherent construction of the cable itself. The compact, multi-layer paper insulation surrounding the cable conductor is designed to function under almost purely radial voltage stress. Termination of the cable obviously necessitates cutting back the cable shield, which causes violent distortion of the stress pattern in the immediate area where the ground shield is removed.

O-B's capacitance-graded potheads are designed to restore the voltage stresses in the terminated area to low, safe values. The capacitance grading creates a uniform potential distribution along the length of the termination, thus eliminating points of overstress.

First step in controlling the termination stresses is to continue and expand the cable ground shield to a larger diameter, accomplished in O-B's potheads by means of a unique, prewound metallic stress cone. Both illustrations (Figures 1 and 2) indicate how the logarithmic-shaped stress cone smoothly expands the ground potential of the cable shield to the point where it joins the concentric assembly of capacitors which takes over the control of the potential distribution.

Figure 1, a schematic parallel is drawn between the electric field pattern established in a typical pothead installation and that existing in a string of porcelain insulators. The equipotential lines (solid lines) indicate that a comparable uniform distribution of voltage stress is obtained for both insulators and pothead.

In Figure 2, the schematic parallel is drawn between the field condition established in a typical pothead installation and that existing in a capacitance-graded apparatus bushing to which it is connected. Aside from the pothead's function of relieving high stresses at the point where the cable insulation is disrupted, potheads and bushings employ very similar methods for uniform distribution of voltage stresses. The equipotential lines indicate the manner in which the voltage-dividing action of the capacitors controls the distribution of voltage gradients.

**Figure 1** — Schematic representation indicating similarity of the control of equipotential lines achieved by both potheads and transmission line insulators.

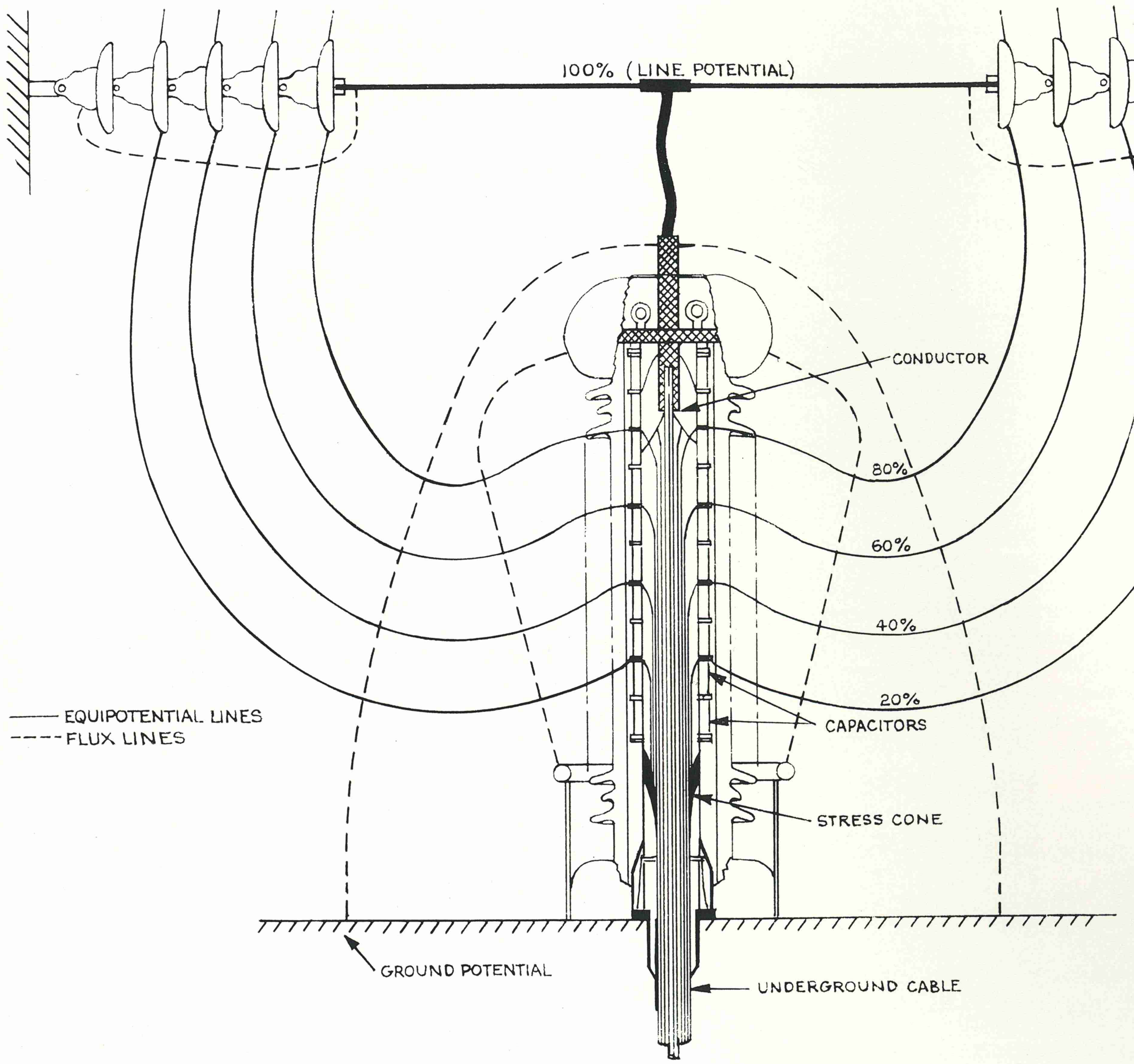
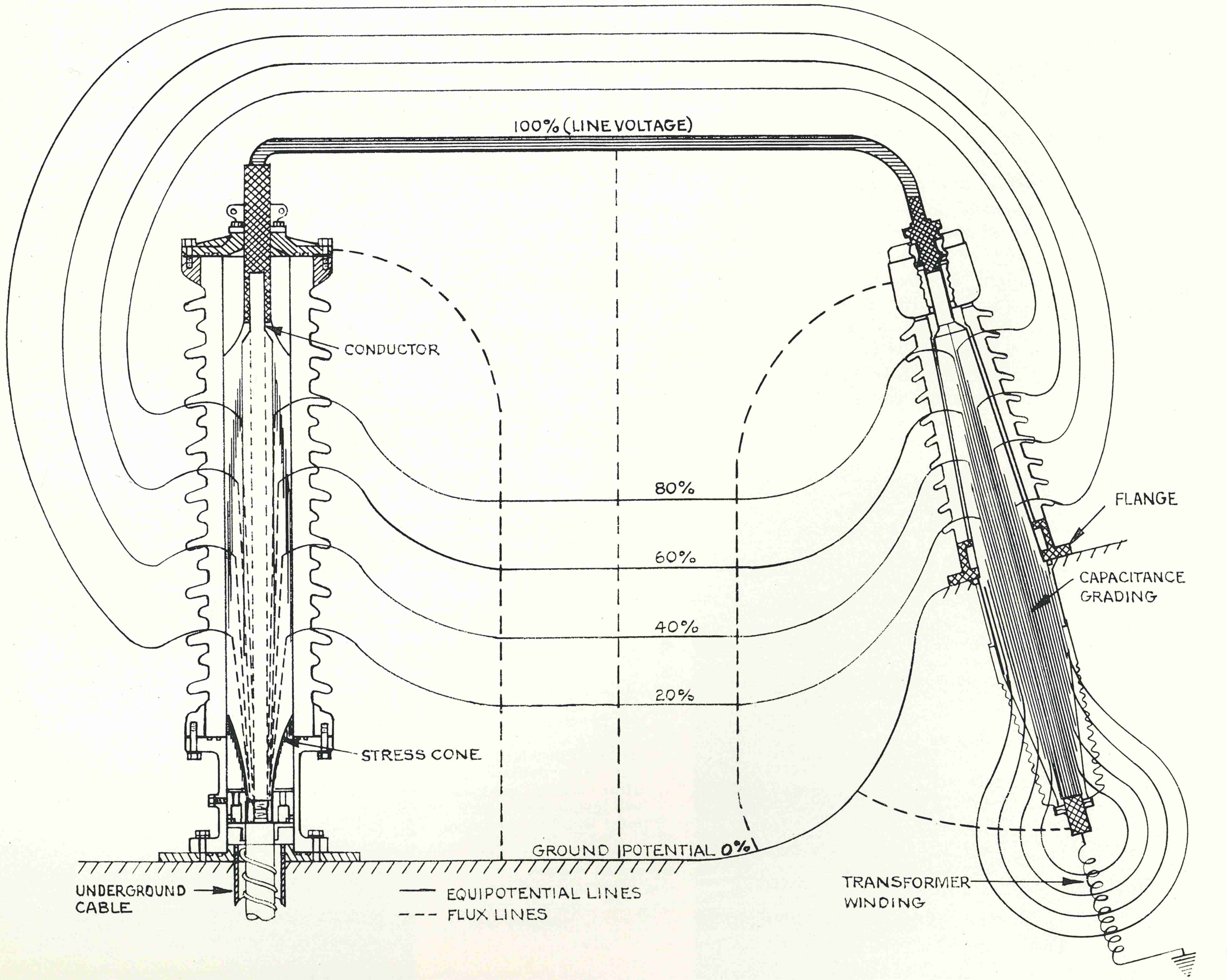



**Figure 2** — Schematic representation of electrostatic field indicating similarities in grading principles in capacitance-graded potheads and apparatus bushings.



# Sorry . . . No Ribbon ! ! !

Once upon a time the purchasing agent said, "Pack 'em so they get here in one piece."

As times changed — so did his advice on packaging. The purchasing agent now makes requests like this: "Package them in quantities of six, palletized in combinations of 12 units, and in a package that will withstand prolonged outdoor exposure."

Since 1960, O-B customers have been taking a more substantial interest in the wrapping in which their purchases are delivered. Prior to 1960, as long as his purchase arrived undamaged, nobody cared.

O-B products then were shipped in containers built to withstand World War II. But then — those were the *"good old days."* In those days customers didn't consider package weight and size. Shipping and handling costs were nominal. Plenty of labor was available to handle the package on delivery. It mattered little whether the package weighed 50, 100, or 150 pounds. In fact, the weight of the product might constitute only 10 or even 20 per cent of the total package. Few customers cared. Their feelings were that *all* products had to be packaged. Most manufacturers believed costs involved were unavoidable and approximately the same as those of the competition.

But as times can change rapidly, so can points of view. Industry awakened to the fact that distribution costs were spiraling. In many cases the cost of distribution nearly equaled the cost of manufacture — or was *at least* a significant part of the total cost of the product. Because many manufacturers were also customers, suddenly *everybody* became conscious of handling costs. Here was an area where little or no expense analysis and control had been exercised. Packaging and shipping efficiency became a habit.

O-B customers began considering the cost of receiving, storing, and transporting to job site. They began exploring more efficient methods for handling their purchases. They began to devise shortcuts. These shortcuts affected O-B methods of packaging.

Our customers, however, weren't ahead of us in their concern over packaging costs. O-B was also aware of a need to examine the economy of our packaging methods. To remain competitive we realized we had to meet the packaging challenge. We had to reduce our own wrapping and delivery costs, while at the same time we had to give our customers the kind of economic packages they wanted — packages that made their costs and labor in receiving and storing acceptable.

Our customers told us they wanted a package that fit *their* handling methods, stored conveniently in their warehouse areas, transported easily to the job sites and was labeled for quick identification.

We evolved our package program from experience — our customers' and ours — with handling and storing O-B products. Our packaging designers conducted extensive research to determine prevailing storage and handling methods and designed O-B packages to fit them. In the ultimate package style we tried to achieve as much standardization as was possible. The motivation for "standardization" was "economy." "Economies" are possible by reducing labor needs and storage requirements.

Standardized packaging keeps the factory operation simple. O-B personnel learn which package to use for each product and how to use it properly for safe shipment. Your purchase goes out our door, on its way to you, faster. In addition, your purchase arrives the way you want to see it, in a package you're prepared to handle. Your products arrive in the same kind of wrapping each time. Your personnel become familiar with its handling requirements, are able to identify it, and can transport and store it more efficiently.

Our packaging program involved two objectives: to meet the ever-changing customer requirements and to reduce costs of packaging, shipping, and handling.

At O-B we have two distinct and different customer requirements:

Our Original Equipment Manufacturers want compact packages designed for mechanical handling from receipt, to storage racks, to assembly area, which when empty can be quickly and efficiently disposed of.

We have attempted to answer this need with our UNIT LOAD package. UNIT LOAD is a well-defined unit of material, designed to be handled with machines such as a fork truck, skid truck, or crane.

A UNIT LOAD is available in two basic sizes: 30-inch by 40-inch and 42-inch by 42-inch. Each comes in two standard heights. We pack 65 different items in UNIT LOADS, plus all O-B Type-DA Multiresters. We also can pack bushings 69 kv and below in six packs. In addition, we have redesigned our entire line of bushing crates to make unpacking and repacking 92 kv and above as simple as possible.

Our utility customers, on the other hand, have requirements which have changed substantially in the 1960's and are continuing to change as their construction methods evolve. We are trying to meet these requirements as we understand them.

Utilities prefer packages of 100 pounds or less of material that can be machine transported and unloaded. For most station insulators of 34.5 kv and above, posts and multiparts of 69 kv and above and transmission-type material today, utilities prefer one piece per package. One piece per package reduces weight per package. Supplying and stocking spare units becomes a convenient operation, saving time and labor.

For large station insulators, line posts, and multiparts, we have been packing one per package and palletizing the packages as standard procedure. This procedure satisfies the minimum weight desired per package and makes stocking of spare units convenient and more economical. It also allows for mechanical unloading, transporting, and stocking.

Another solution we have adopted to solve our customers' problems is the Rigid Wet Carton. The Rigid Wet Carton is dipped in a paraffin-type liquid which penetrates through the carton body. It has a non-water-soluble adhesive construction. The Rigid Wet Carton is excellent for exterior storage where the package is exposed to weather. We have shipped about 150-thousand Rigid Wet Cartons to date. At present they appear to satisfy specific needs in some areas.

In the other packaging areas we have the typical "crate" with open space between slats. Crates are usually constructed of one-inch nominal lumber. We also utilize, whenever possible, our standard carton with an outer double wall and double-wall partitions.

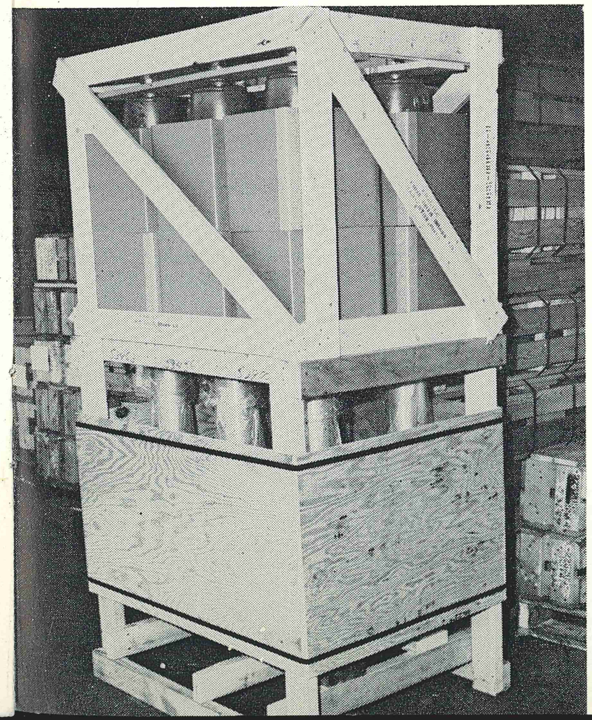
O-B cartons are printed with the O-B monogram for immediate identification. Immediate identification is, of course, a primary requirement by all our customers. We have attempted to design labels that are sufficiently large, bright and clear in description, with a product illustration, to make positive and immediate identification possible.

Our packaging program will continue to evolve as our customers' requirements change. We hope you will help us evolve better and more efficient packaging by keeping us informed as your requirements change.

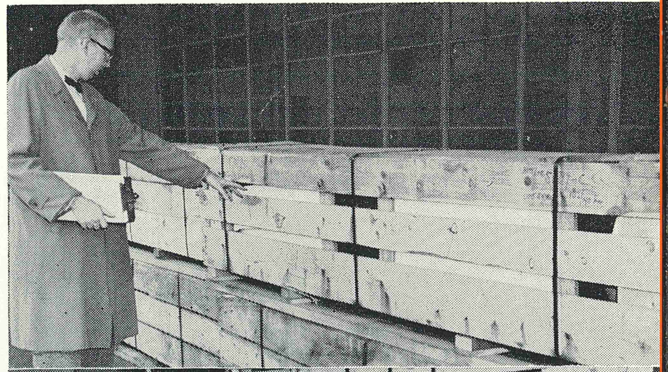
Next time you encounter a packaging or storage problem, discuss it with your O-B district manager. Whether your problem is unique or common, we'll do our best to find a solution, through an effective packaging design.

New, these outdoor cartons are brown and waxy in appearance. In storage, they weather to a lighter tan. As a result, labeling becomes more prominent in contrast. In severe weather these cartons are expected to last a year.

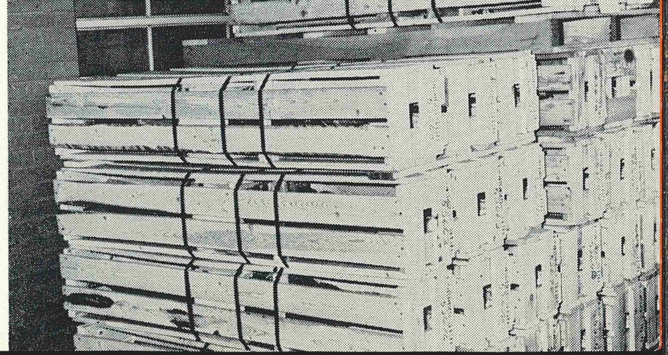
This pallet of 18 cartons of Number 31152 insulators is typical of current O-B packaging practice. The outdoor, paraffin - coated containers will last at least a year in most weather conditions.



Another "kind" of crate package is this "six pack" of 69-kv bushings. Plywood siding protects the product and adds strength to support the height of the package.



For the "really big" items like MPR 250-kv arresters, these heavy-duty crates are used. Styrofoam padding protects the product in shipment and storage from drop damage.



For "medium - size" items, like these 15-kv bushings, single-dimensional wooden crates are used. Proper storage prevents damage to crate and product.

# New Dynagap 5 station arresters demonstrate distinct superiorities in stringent laboratory evaluations

Comprehensive electrical tests which have been conducted on the new Dynagap 5 station-class lightning arresters in O-B's High Voltage Laboratory have successfully documented the highest evaluation ratings of any design development produced in this category of equipment.

These superior ratings are particularly significant in view of the specialized capabilities of the arrester test apparatus developed and maintained in O-B's laboratory. In addition to the powerful 4-million-volt switching-surge generator shown in Figure 1, various other special surge generators are available for testing purposes and provide facilities by which the entire spectrum of overvoltage surge waves can be duplicated. Most recent addition to the laboratory's arrester test apparatus is the calibrated long-duration current-surge generator which is fully adjustable for accurate simulation of the stored energy discharges associated with switching surges.

The laboratory also functions as an invaluable reservoir of technical experience in developing the test procedures which provide optimum coordination of the unique test facilities, applicable service conditions, and positive verification of precision measurements.

The cataloged specifications of Dynagap 5 arresters are based on the most recent series of USA Standards (C62.1) applicable to station-class arresters. The revised test group includes the duty-cycle test, the high-current, short-duration test, and the transmission line discharge test.

Duty-cycle testing of station-class arresters consists of energizing the arrester with 60-cycle rated voltage then superimposing upon this a 10 x 20 microsecond impulse wave of 10,000 amperes. Twenty operations are required in 20 minutes. O-B's laboratory procedure actually makes the duty-cycle test more severe by imposing 20,000 ampere surges on the energized Dynagap 5 arresters, thus demonstrating the ease with which the standard requirements can be met.

In the oscillogram which provides visual evidence of the arrester's function under duty-cycle testing, the arc-voltage generating properties of the Dynagap 5 arrester are clearly indicated, and it will be seen that this causes arc extinction independent of 60-cycle voltage zero.

The high-current, short-duration test simulates a direct lightning-stroke discharge. Procedure required by the USA Standard for station-class arresters consists of two applications of a 5 x 10 microsecond impulse wave of 100,000 amperes. The oscillograms illustrated record the laboratory application of the specified surges.

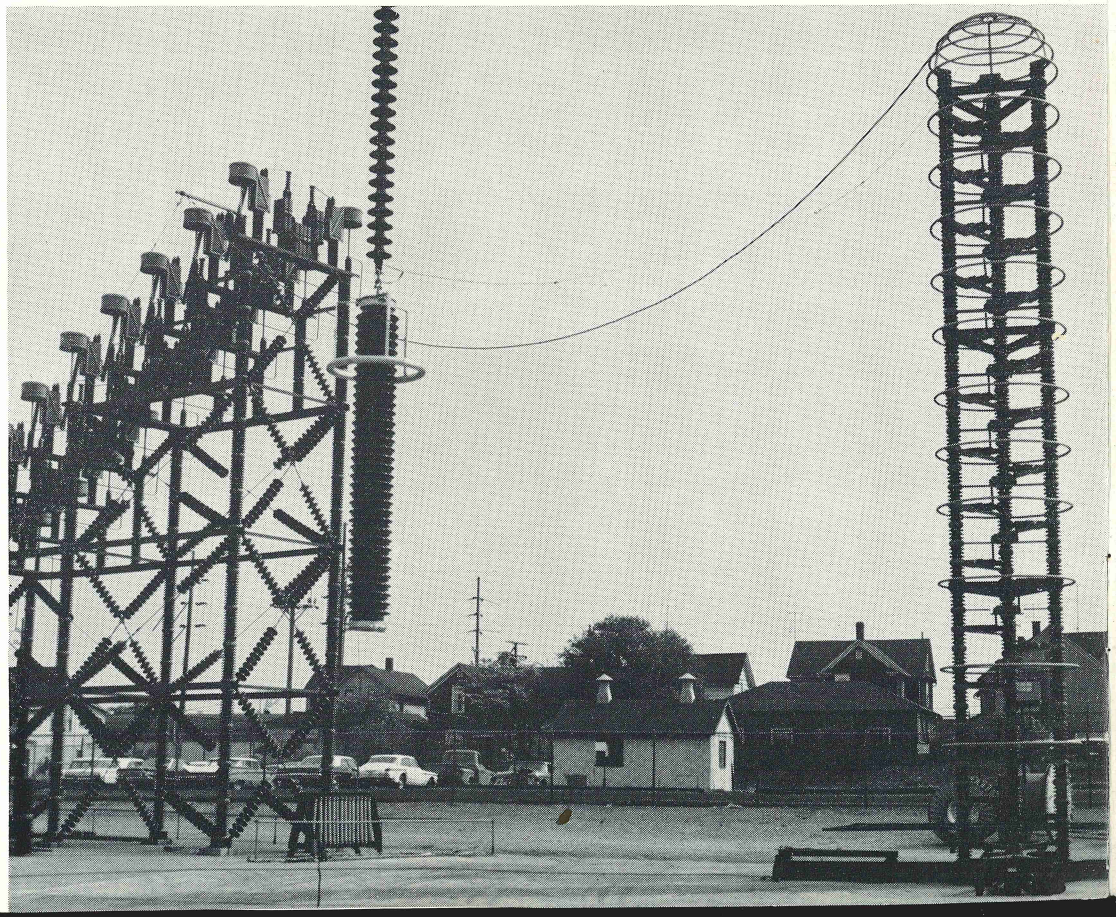
This test is considered extremely conservative. According to authoritative information (AIEE / IEEE Paper 51-190) a lightning arrester has a likelihood of being subjected to a 100,000-ampere stroke once in 14,300 years.

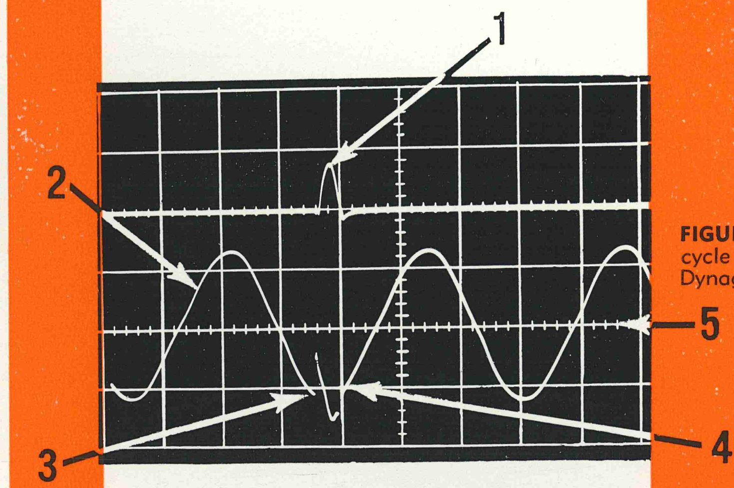
The transmission line discharge test for station-class arresters was incorporated into USA Standard C62.1 in 1965 and replaced the former current-defined "low-current, long-duration" test. The new procedure specifies 20 applications of the energy discharge of an entire transmission line with specified coordinates charged to the maximum switching-surge overvoltage anticipated in actual operation. Tests are made either on an energized complete arrester or on a prorated specimen where the combined function of the arrester elements can act to control the discharge in a manner similar to operation in the actual installation.

Oscillograms obtained from the first through twentieth applications of the transmission line discharge test provide visual evidence for evaluating the arrester performance under the specified coordinates. The oscillograms illustrated are typical examples from a transmission line discharge test conducted on a Dynagap 5 arrester.

Present applications of the transmission line discharge test are reported in tabular form. Maximum per-unit-charge voltages have been determined and listed for typical sets of transmission line coordinates. Durability requirements of most systems will be contained within these specifications, but further testing using actual system values is readily obtainable.

**FIGURE 1** - A 312-kv Dynagap 5 arrester is suspended in the outdoor test yard at O-B's High Voltage Laboratory in preparation for full scale switching surge tests.






1. 60-cycle power follow current
2. Rated 60-cycle voltage applied across arrester
3. Impulse discharge applied here
4. Arrester valve action completed
5. Voltage zero

**FIGURE 2** - Duty cycle oscillogram for Dynagap 5 Arrester.

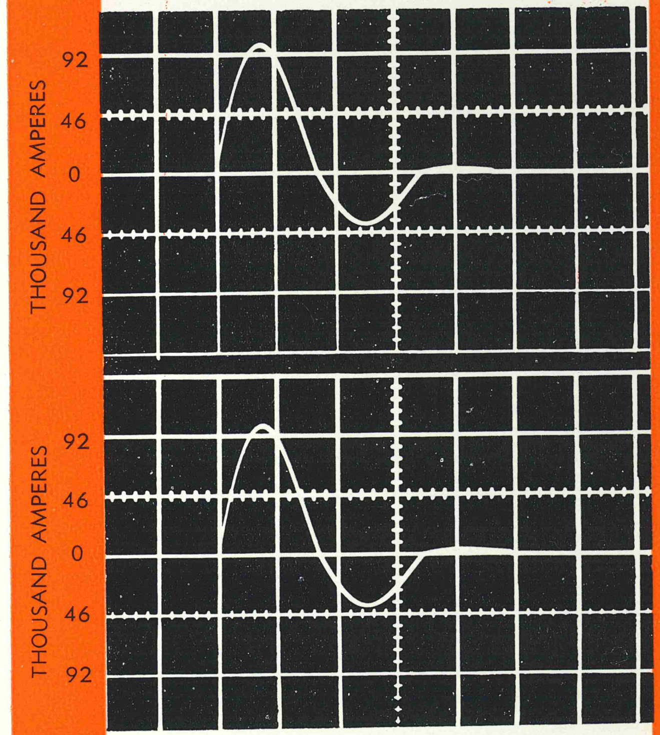



**FIGURE 3** - Oscillogram record of successive application of 5 x 10 microsecond impulse waves of 100,000 amperes.

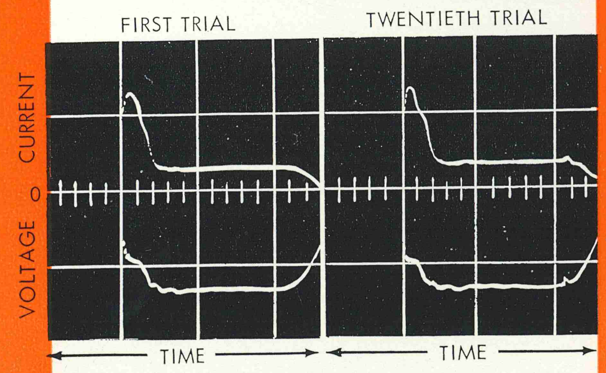
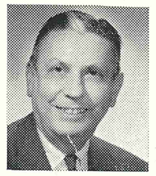



**FIGURE 4** - Transmission line discharge test oscillograms from first and twentieth trials provide visual proof of durability characteristics of Dynagap 5 arresters.

OHIO BRASS MANAGEMENT REPORT

# We look through the windshield at our business and its future

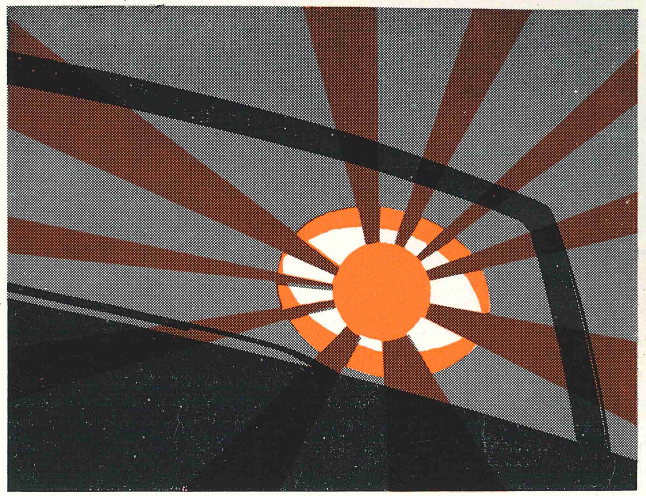
**BY ROGER A. BLACK**
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY



Every company should ask itself: "What business are we in and what business do we expect to be in five years from now, and ten years from now?" Then we can answer effectively an indictment by a popular social philosopher. He says that most people, including people in business, look at the world through a rear-view mirror rather than through the windshield. We still live, he says, in "Bonanzaland" where the good guys (in white hats) shot it out with the bad guys. Life was rugged, but simple. We would like to stay in Bonanzaland rather than cope with the electronic age, or so his theory goes.

**YOU PROBABLY ASK YOURSELF** what business you are in. Are you dedicated to supplying "electrical energy" or "energy" in any form? It's possible that the difference of one word could mean a big difference in how you approach tomorrow's problems.

**IF YOU ASK US** at Ohio Brass what we make, "electrical porcelain" would be a reasonably broad description of our product line for utilities. But then we look at the Holan Division and see fiberglass arms on the elbows. We see paper being used as an insulating medium in bushings, potheads and capacitors. Already, we realize that porcelain is just one insulating material, good as it is. So we remind ourselves that we are in the "insulation" business, regardless of what the material may be, today or tomorrow.



**CONSIDER ALSO THE PROBLEM** of making overhead line construction look attractive. Already the electrical industry has seen that when we free ourselves of traditional concepts on shapes and materials that overhead can be made aesthetically acceptable, *and* more reliable. More progress can be expected as the industry's task force committees swing into action. Or look at what windshield thinking has done to a product like the lightning arrester. Once we freed ourselves of the idea it was just a perfunctory standby device, we discovered all sorts of new values in its application. Again, we're really just getting started in exploring what it can do to improve system reliability.

**SO WE MUST SEEK** the challenges, looking ahead through the windshield, before they seek us. Bonanzaland was wonderful but it isn't home any longer.

762-H

THE OHIO BRASS COMPANY • MANSFIELD, OHIO • 44902
Canadian Ohio Brass Co. Ltd. • Niagara Falls. Ontario, Canada

OHIO BRASS

6706-H

Hi-Tension News

JUNE 1967

# The right metal . . .

# in the right place

Most insulators have metal components . . . metal is sometimes as much in evidence as porcelain. An insulator manufacturer who is not a metal producer has control over only part of his product. And then there are the thousands of hardware accessories: clamps, links, shackles, to name a few. These must work with insulators, and must never penalize the insulation by improper design.

O-B runs the entire gamut of metal production. This starts in the metallurgical laboratory where alloys are investigated or, if necessary, developed to meet requirements dictated by service conditions. Men in this branch of manufacture have won national recognition for contributions to the science of metallurgy. More frequently they concentrate their attention on putting the right metal in the right place. In doing this they are faced with no obstacles or prejudices, because unlimited facilities are at their disposal.

A complete product development department deals exclusively with O-B high-voltage hardware. These men work closely with insulator designers so that materials are properly coordinated. In other words, men working together make products that work best together.

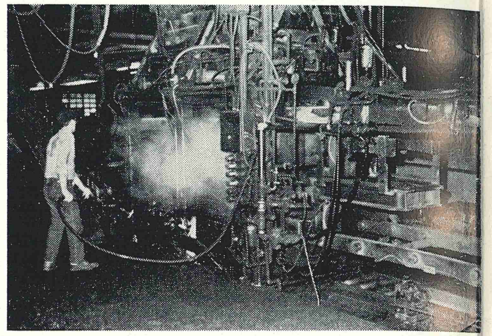
And this "togetherness" implies a single responsibility for the best performance of the combination of these materials.

An O-B engineer has perfectly free choice of casting in either ferrous or non-ferrous metals. If casting is undesirable, he has a large fully equipped forge shop at his disposal. He has his own heat treating department, his own metal finishing operations, his own galvanizing plant, his own specialized inspection and testing facilities. From the laboratory to the shipping dock he controls the suitability and the quality of the metals he works with. Only at O-B is insulation and metal production so closely coordinated and so specialized.

From years of experience we have learned that certain products perform best when made of malleable iron, or steel, or bronze, or aluminum. The metal best suited to meet the needs of the application is selected. Another would be just as easy to supply. Never is the choice dictated by the fact that we are wedded to some metal or some process or that we have no suitable source of supply for a certain material.

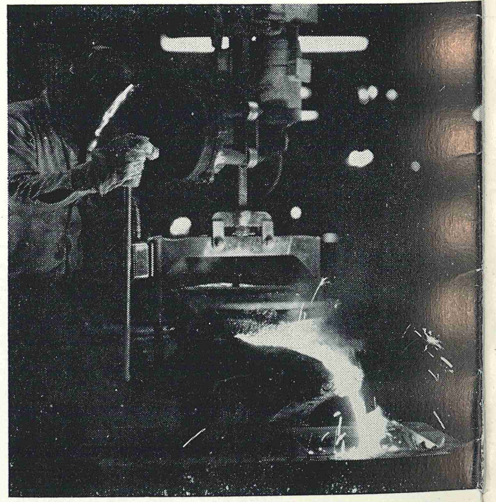
Buyers of O-B insulators and hardware have the assurance of knowing that the right metal is in the right place.

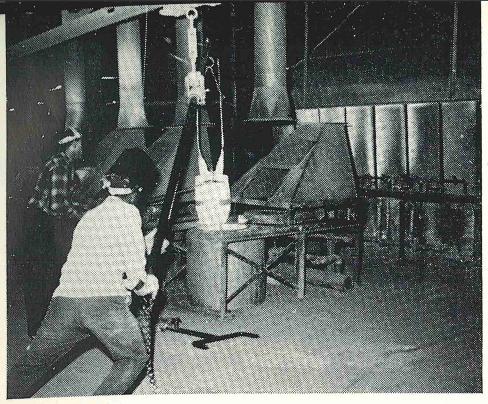
1 — Tapping one of the malleable iron furnaces. From here, molten metal is taken to the pouring floor by overhead conveyor.



2 — In addition to a line of hand moulders, O-B operates this automatic moulding machine for high production of repetitive malleable iron castings, such as suspension insulator caps. This is considered one of the most advanced examples of modern foundry mechanization.

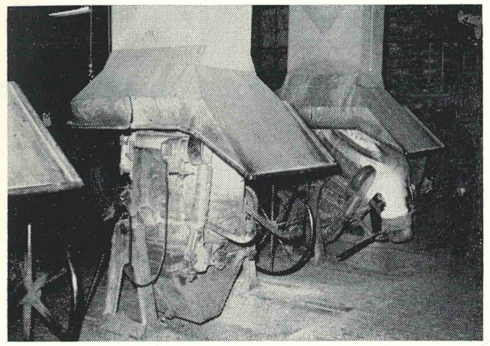
3 — Both moulds and metal travel on conveyors to the pouring floor. The O-B malleable iron foundry is recognized as one of the most modern in the industry. Convenience and mechanization are valuable aids in obtaining both consistency and quality in the final product, as well as high production.

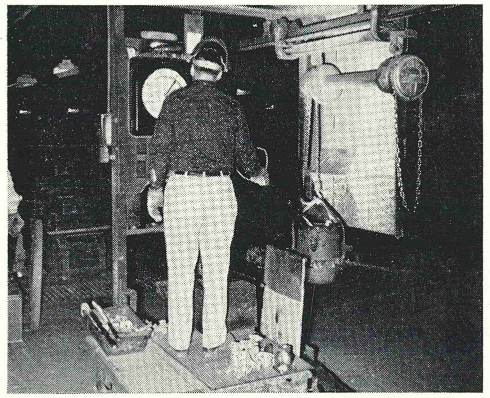




4 — In the non-ferrous foundry a small cauldron of special bronze alloy is heated in a crucible furnace.

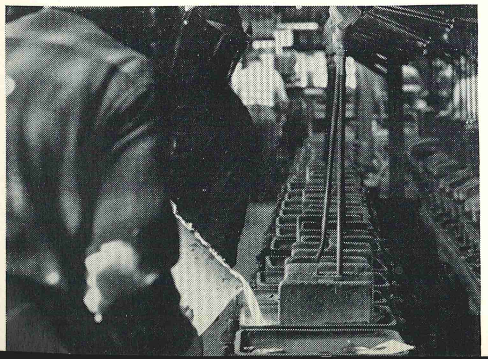
5 — For general production in the non-ferrous foundry this battery of induction furnaces is used. Such furnaces represent the most modern approach to the proper heating of these metals.

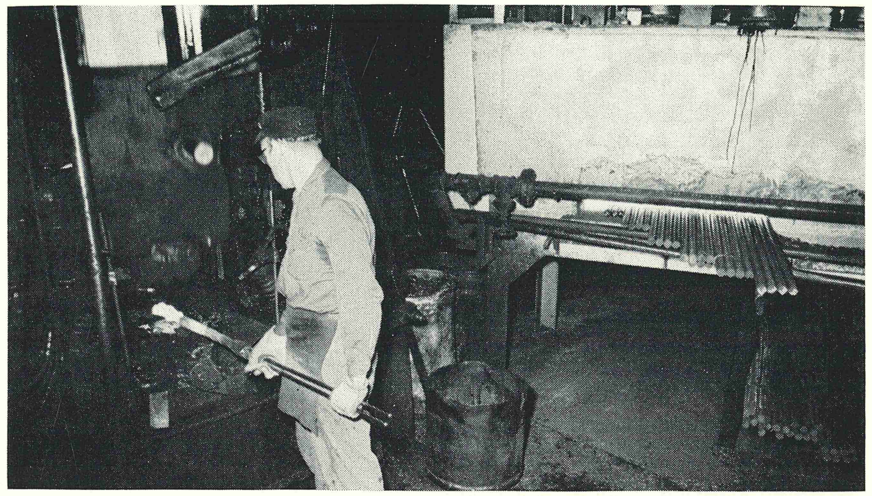




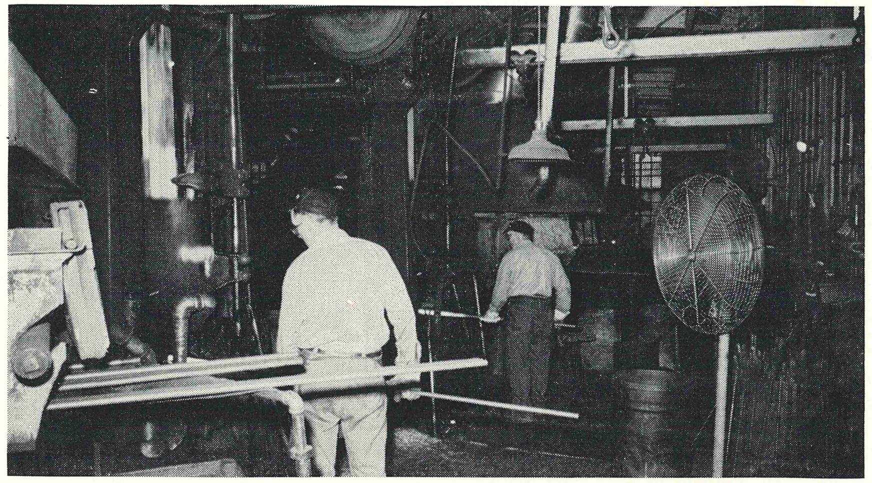
6 — Molten non-ferrous metals all pass this station where exact pouring temperature is confirmed by pyrometer measurement.

7 — Non-ferrous metals, being somewhat less fluid in their molten state, are normally poured in smaller moulds. Pouring temperatures are quite precise and the metal must be quickly handled. For these reasons the non-ferrous foundry uses smaller equipment and retains many traditional hand operations.



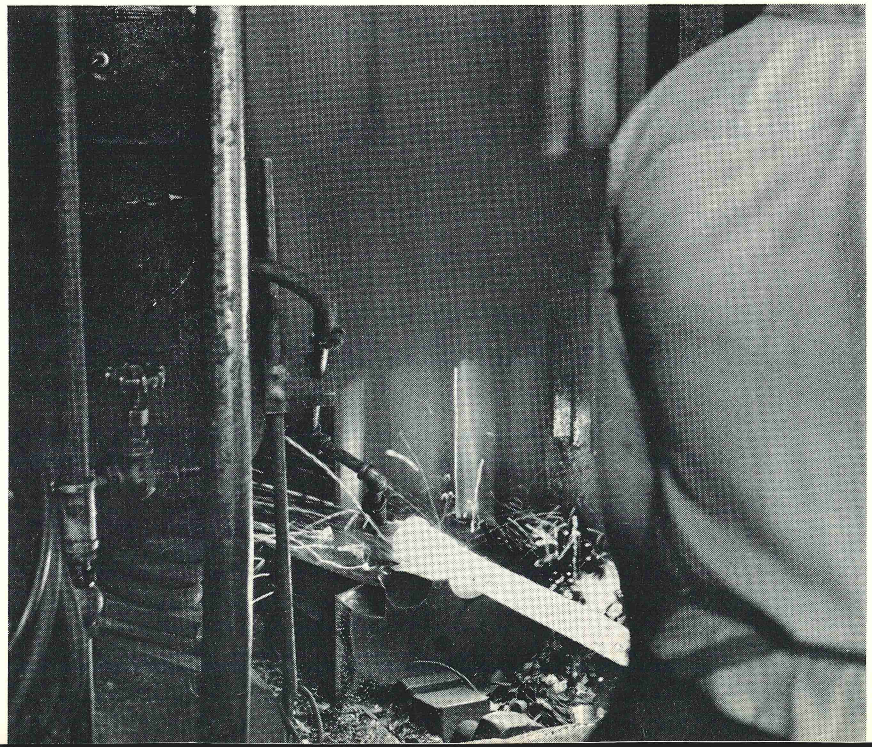


8 — Drop forging a steel suspension insulator pin. Heating ovens maintain correct temperature so that the metal stock receives a thorough "soaking" at a specific heat before and immediately preceeding the forging operation.



9 — Part of the line of drop forges in the O-B shop. As one progresses down the line he will see a series of forges of graduated capacity, permitting lighter, faster machines to be employed for smaller pieces.

10 — One of the largest forged parts supplied by O-B is formed under the Number One heavy hammer. Graduated capacity of a series of hammers makes this operation highly efficient.



O-B Hi-Tension News
June 1967, Vol. 36, No. 6

**ON THE COVER** — We don't have to compromise in picking the right metal. The Ohio Brass Company maintains the finest facilities for ferrous and non-ferrous castings, as well as drop forging. On the cover is one of our larger hammers in action.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

# O-B's identification method for EHV hardware assemblies greatly reduces errors

Whether your conductor suspension system for a proposed EHV project is a basic twin-line, single-string insulation design, or a more complex type for a triple bundle, possibly involving V-strings, there are a number of mechanical details to consider, and a number choices of fittings to make.

For example, Y-clevises connect the conductor clamps to the yoke. There are possibly varying dimensions in these pieces. This detail reappears at the fitting between the yoke and the insulators . . . and so on, all the way up to the tower. We try to keep it simple, but the necessary range of choice results in many different available pieces.

It was traditional, in the days of conventional hardware, for the user to specify what he wanted from a catalog. When V-strings and multi-conductor assemblies first entered the picture, unfamiliarity with some of the new fittings and their application led to misfits and unnecessary confusion. Today you order these from O-B as a package, and with a minimum chance of error.

First, obviously we have to know what you want. Your requirements develop from conference with our engineers, leading to a specific proposal. This always falls into some general category, such as "double-conductor V-string, standard strength." Every basic assembly has a catalog number.

Added to the catalog number is a four-digit code number that describes details of the device. Since no two pieces of supporting hardware are likely to be duplicates, the code number often becomes, in effect, your private property.

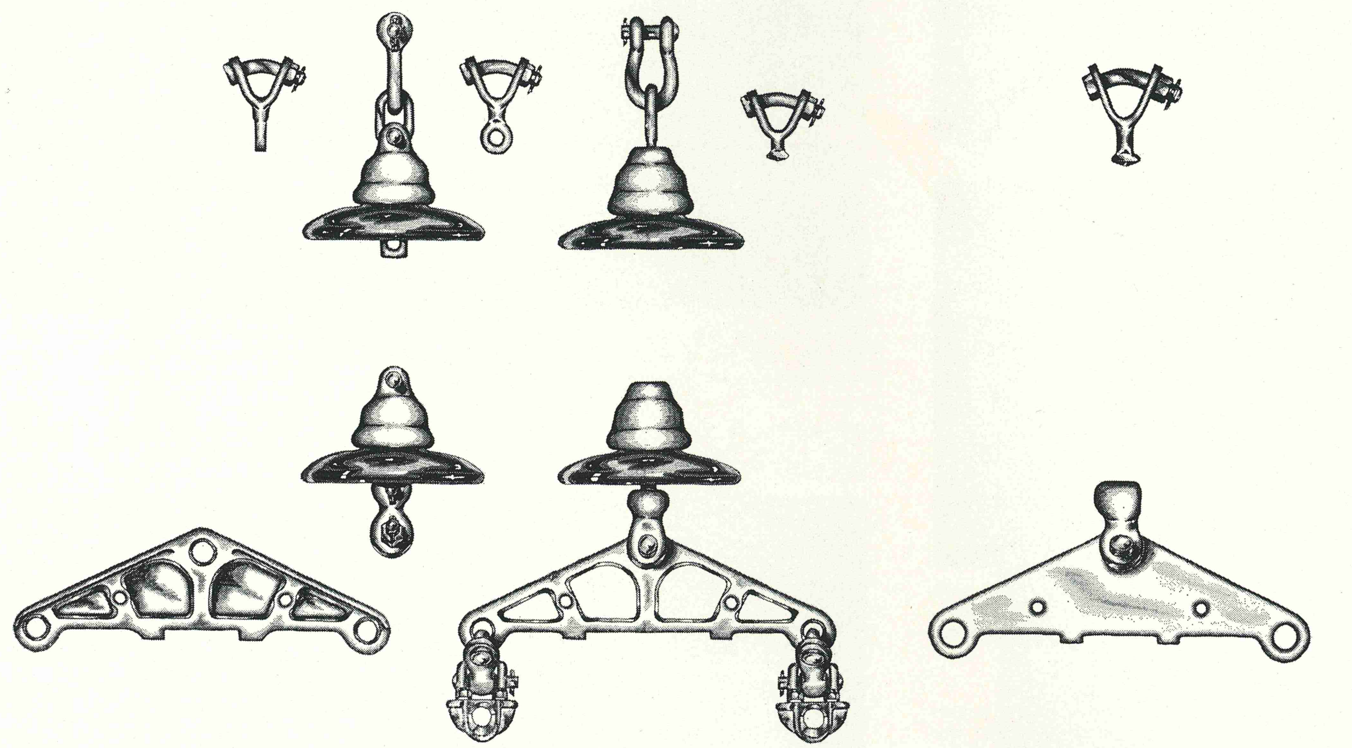
An assembly according to a certain code number is checked for fit of all parts as well as for compliance with specifications. This code number is then applied to a packing list.

Use of a combined catalog and code number often saves endless trouble. For instance, one of your engineers might telephone one of ours concerning some detail. Our man could quickly retrieve the exact information and have it before him. They would both be talking from the same set of data. Lacking this, misunderstandings would be very easy.

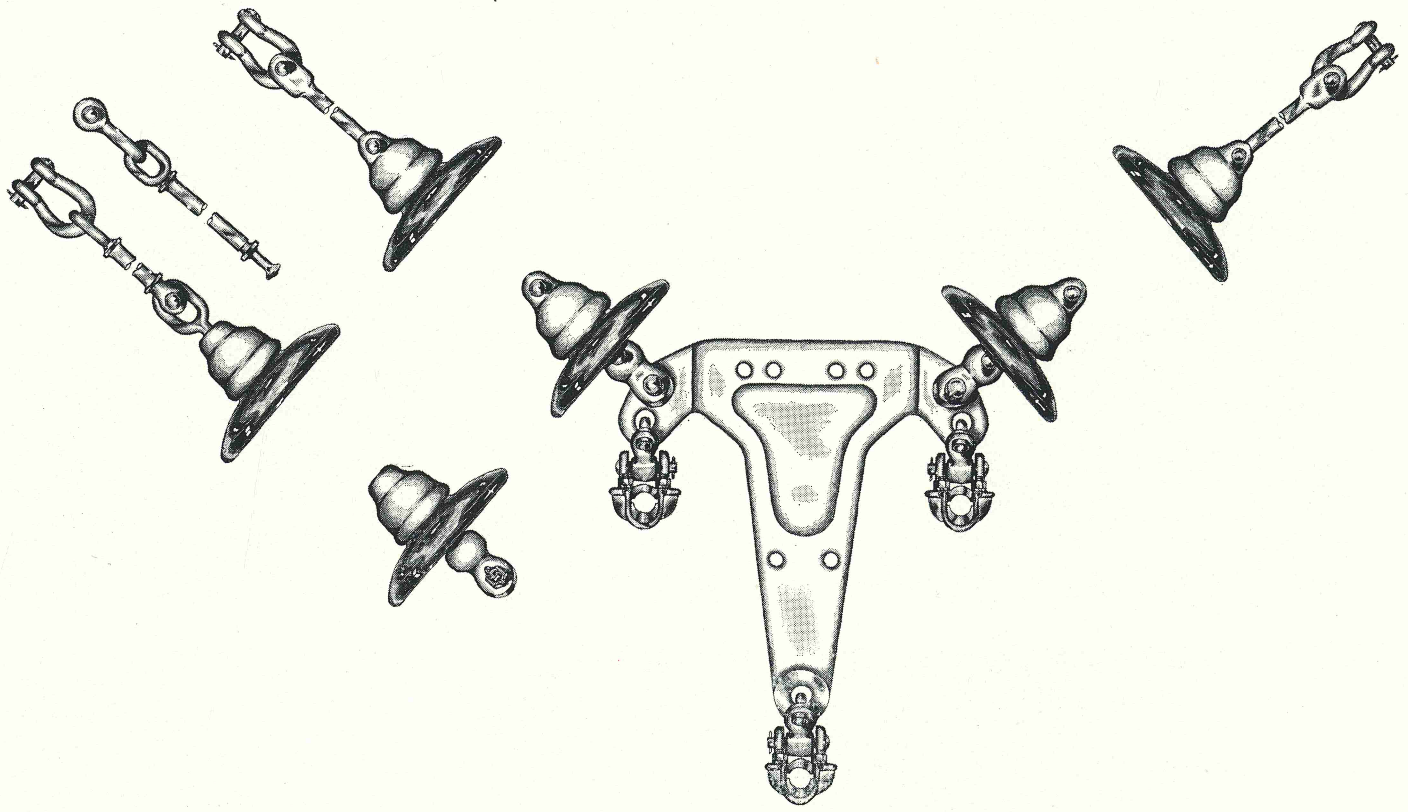
Ordering requires no lengthy descriptions . . . merely the complete identifying number. The description is a matter of mutual records.

If an assembly is ever modified, a new code number is assigned. No longer do we operate on the basis of "similar to, except . . ." With four digits, there is never any shortage of code numbers, so why not be specific?

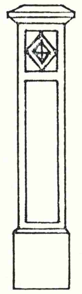
Your O-B district manager will gladly clear up any questions you may have regarding this system of hardware identification. As far as we know it has met with universal approval, since it clarifies an otherwise potentially confusing mass of detail.



Consider the possible alternates in this simple basic twin-conductor, single-string EHV hardware assembly: Clamp seat diameter. Y-clevis between clamp and yoke. Strength rating of yoke. Fitting between yoke and insulator. Strength rating of insulators. Type of insulators, ball-socket or clevis. Tower connection fitting. Combinations running into the hundreds are presented. Instead of describing them in a page full of words every time they are discussed, all details are agreed upon in advance and this specific assembly is then given a code number. In the future, the basic catalog number, plus the code number, is absolute identification. The assembly is shipped according to this code number which specifies a specific packing list.



Triple-conductor assembly for V-strings has all the elements of the previous piece, plus a wide variety of types and lengths of extension links. It would be hazardous for two men, miles apart on the telephone, to trust a verbal description in discussing the relationship of certain parts. A code number for reference, however, pins down every detail and permits a clear understanding between the two parties in a conversation.



# THE NEWELL POST

## to support industry's climbing needs

A *newel post* is the central upright around which the steps of a circular staircase wind, or the main post support at the foot of a straight stairway.

Ohio Brass has added dimension to this definition of a *newel post.*

The accompanying photographs illustrate O-B *Newell Posts.* These are the first station and line posts to be produced at the new O-B manufacturing facility in Newell, West Virginia.

We make the comparison and play on words *newel* and *Newell* because O-B Newell will shortly become a major support in the supply of station and line posts to meet the electric industry's spiraling post demands.

Leased in May, 1966, the West Virginia facility began preparations for attaining full production status at once.

While renovation of plant proceeded *posthaste,* and equipment was installed, assembly of suspension insulators was transferred from O-B Barberton to O-B Newell.

In our May issue of *Hi-Tension News* we reported that Newell was producing clay for trial runs on its pug mills.

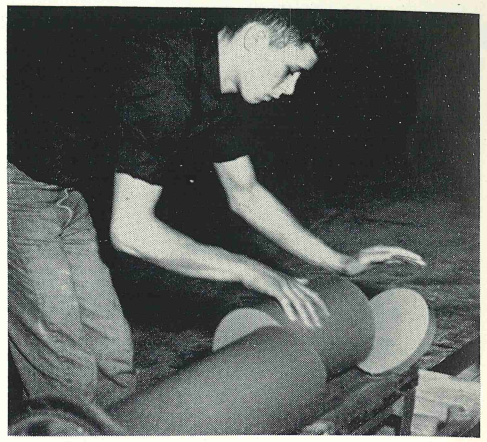
Since May we are happy to announce that the clay room is producing clay daily. In addition, blanks for both station and line posts are being extruded, trimmed and await introduction into the tunnel kiln.

Assembly of line posts is in the transferal stage from O-B Barberton to O-B Newell. Eventually all line post assembly will occur at O-B Newell.

O-B Newell contains 356,000 square feet of manufacturing space. Two continuous kilns have the potential to increase O-B's total porcelain-producing capacity by 33 per cent.

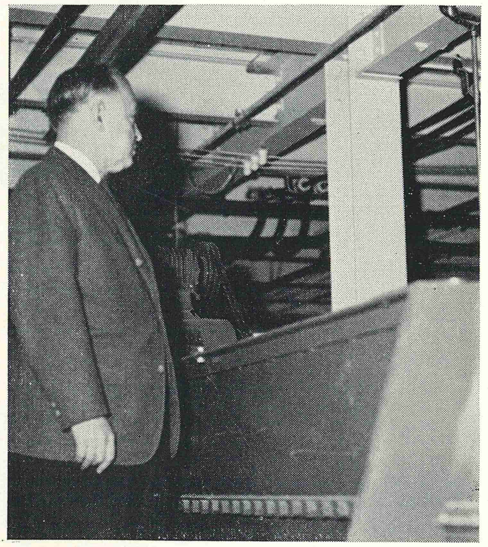
As utilities needs for posts climb, O-B Newell will fill them.

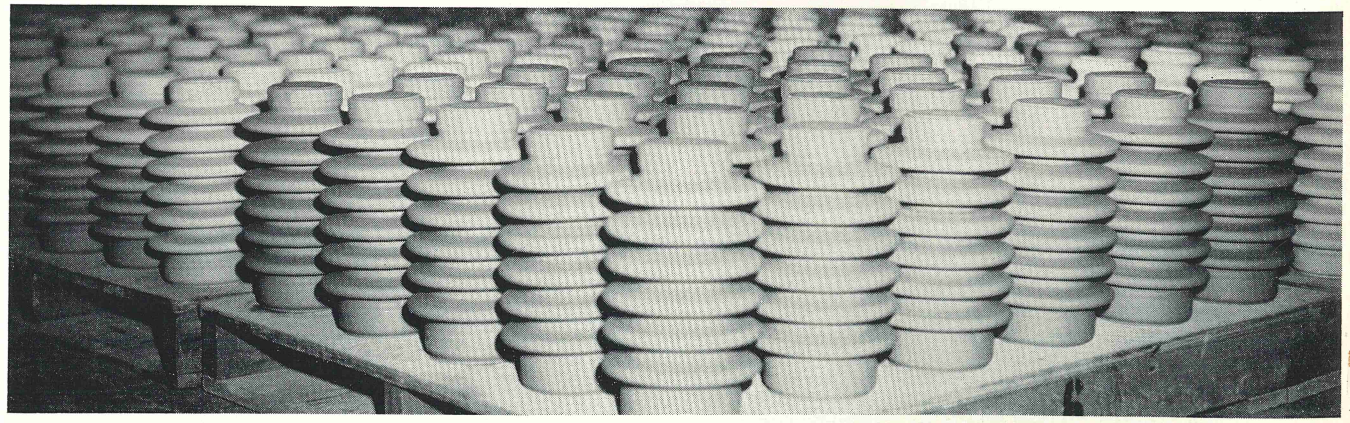
As O-B Newell develops, *Hi-Tension News* will keep you constantly informed.



Clay blanks are extruded for future trimming into station posts.

Mr. E. C. Thompson, vice president, manufacturing, inspects the new pug mill installed at the Ohio Brass facility, Newell, West Virginia.

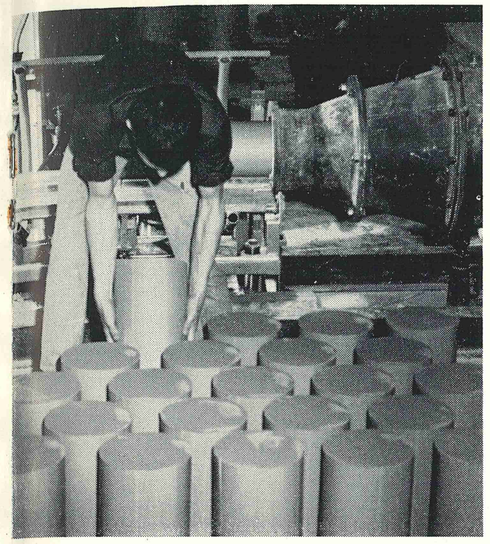




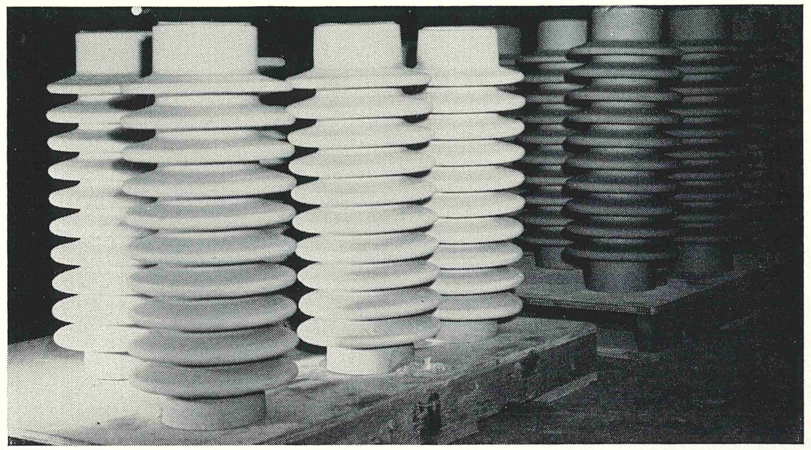
Line posts, clamptop and tie top posts produced by Ohio Brass Newell facility, await glazing, firing, and assembly.

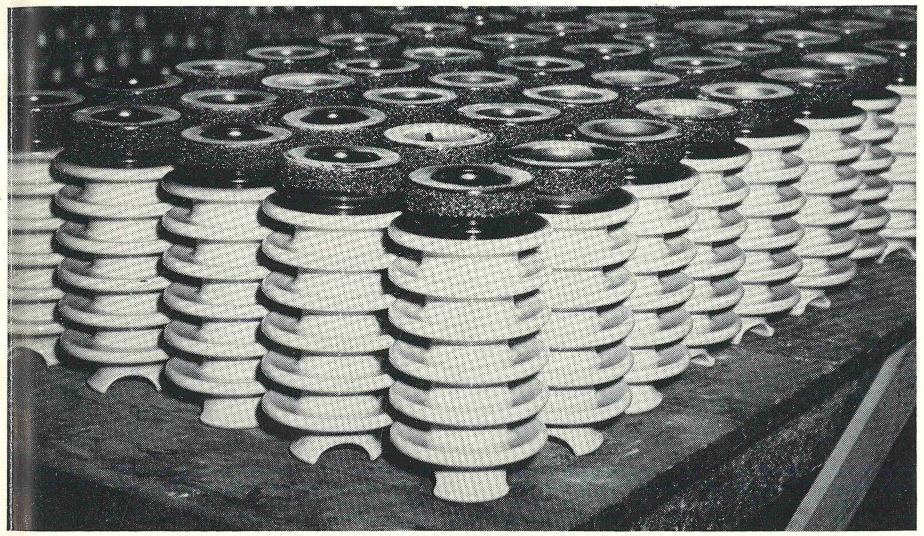


Newly extruded clay blanks stacked on pallet for transport to drying area.

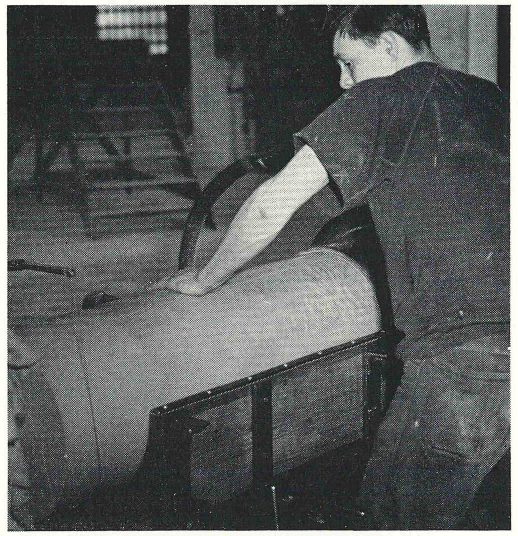


First trial station posts produced by new Ohio Brass Newell, West Virginia facility.

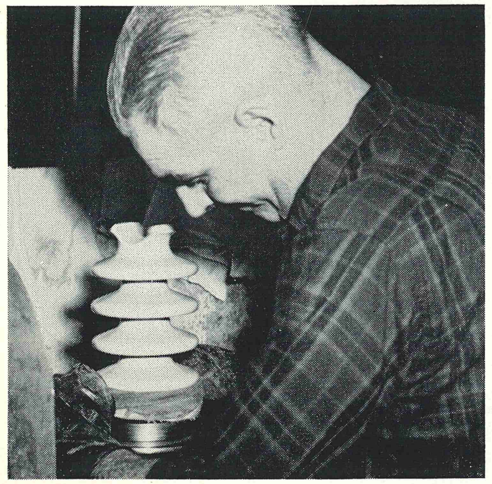




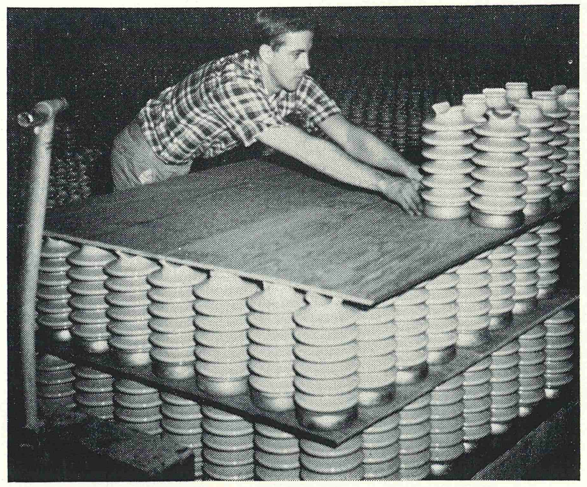
Line posts await cap assembly.



Clay blanks are extruded for future trimming into line posts.



Line post receiving final cleaning.



Assembled line posts stacked for transport to packaging area.

# Protective features of intermediate arresters provide economical increases in reliability

## Heavier loads on feeder lines emphasize durability advantages of GP Dynagap arresters

Recommendations specifically outlining the conditions most suitable for the installation of intermediate-class lightning arresters have been subject to many variable qualifications. Certain guidelines can be described, however, which should assist utility engineers in recognizing the broadening category of applications where the improved protective features of The Ohio Brass current-limiting gap intermediate arrester can provide greater assurance of system reliability.

In considering the economics of intermediate arrester installations, the initial inclination is to weigh their substantial savings against the superior performance provided by modern station-class arresters. While this approach may be applicable for some locations and satisfactory compromises occasionally reached, the more logical viewpoint uses the economy and capabilities of the current-limiting gap intermediate arrester as major factors in planning arrester installations in locations where inadequate protection is known to exist.

Actually, in the area of protective characteristics, Ohio Brass Type GP current-limiting Dynagap intermediate arresters approach those of station-class arresters. In fact, the incorporation of the current-limiting series gap into O-B's intermediate arrester improved its performance characteristics to levels which exceed those of station-class arresters with conventional gap assemblies.

The outstanding performance record established by the thousands of Ohio Brass GP intermediate arresters installed throughout the country is based on virtually trouble-free operation under a multitude of widely varying field requirements. Ability to predict satisfactory protective performance results to a large degree from the thorough laboratory test procedures which are designed to evaluate the arrester's qualifications.

Two of these laboratory tests, duty cycle, as shown in Figure 1, and high current, short duration, as shown in Figure 2, continue to be conducted according to the long-established specifications contained in USA Standard C62.1.

The third major test included in the laboratory evaluation of intermediate arresters has recently been completely revised to provide a more realistic measure of arrester durability. This procedure was formerly known as the low-current, long-duration test and consisted of 20 successive applications of a prescribed square-wave-impulse current. Because the gap structure of the arrester was not permitted to control the extent of the discharge through the valve blocks, this test was meaningful only to the degree that it indicated the thermal capacity of the valve blocks. In the case of current-limiting gap arresters, this did not show the discharge capability of the arrester.

Industry's new durability test is known as the transmission-line discharge test. Its procedures, as now specified in USA Standard C62.1, rectify the inadequacies of the former method, since the arrester is permitted to function on test as it would function in a field installation. The similarity is further extended by modeling the energy discharge generator to the parameters of the actual transmission line, so that the wave front and duration of the test surge discharge simulate a realistic service condition. The arrester's capacity for current discharge is indicated in the oscillogram of Figure 3, and a measure of its durability comes from the comparison of the first and twentieth trials.

Arrester durability is rapidly becoming a most important factor in the selection of protective equipment for subtransmission systems and for both high- and low-voltage distribution lines. Feeder-line lengths and connected equipment have increased to proportions where overvoltage surge discharges through conventional or older-model high-voltage arresters may exceed their thermal capacities. Only station- and intermediate-class arresters with current-limiting gap construction have the inherent control over discharge currents which provides the necessary limiting force for safe operation.

A similar situation is reflected in the trend toward the use of intermediate arresters in locations where distribution-class arresters have customarily been installed. Of special interest is the number of intermediate arresters being specified for the protection of underground distribution cables, where their lower sparkover values and greater durability are essential to high-reliability service.

The comparison of the GP intermediate arrester with other models is not complete without mentioning its facilities for pressure relief. The two-stage, pressure-actuated system for exhausting the arrester cavity is similar to that used on O-B's station-class arresters and provides a high degree of safety of operation in case of internal damage under either low- or high-current fault conditions.

The accompanying tabulation lists major features of O-B's station-, intermediate-, and distribution-class arresters. All are available in ratings as low as 3 kv. The station-class arrester is offered in a continuous range of ratings extending through the highest EHV yet proposed. Highest voltage rating of intermediate arresters is 120 kv, while maximum distribution-class rating is 37 kv.

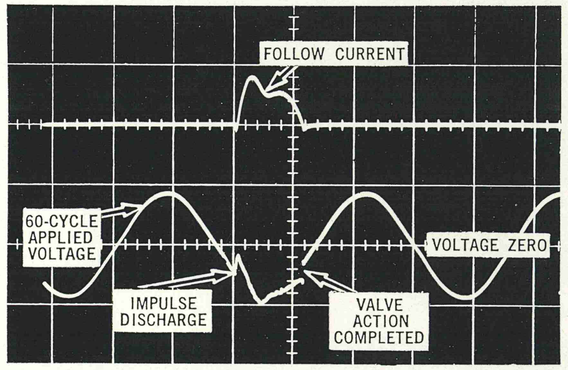



Figure 1 — USA Standard Duty-Cycle Test for intermediate-class arresters is performed with 60-cycle rated voltage applied to specimen, then superimposing an 8 x 20-microsecond impulse wave of 5,000 amperes.

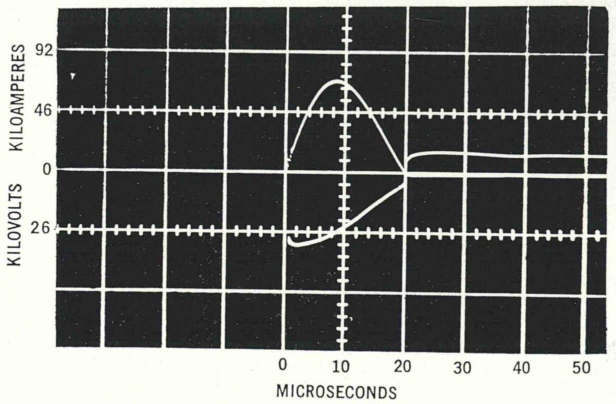



Figure 2 — USA Standard High-Current, Short-Duration Test for intermediate arresters consists of two applications of a 5 x 10-microsecond impulse wave of 65,000 amperes, simulating a direct lightning discharge.

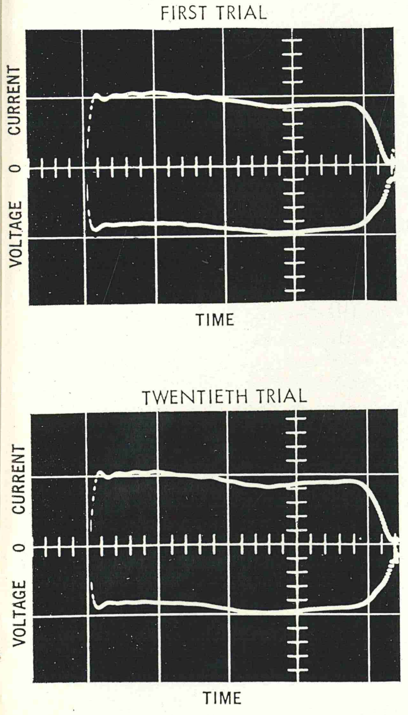



Figure 3 — USA Standard Transmission-Line Discharge Test is based on a maximum system voltage of 150 kv, an effective line-surge impedance of 450 ohms, a line charge voltage of 2.6 per unit, and a line length of 100 miles.

| Thorex Dynagap 5 Station-Class Arresters | Thorex Dynagap Intermediate-Class Arresters | Thorex Multirester Distribution-Class Arresters |
|---|---|---|
| 1. Advanced-design current-limiting series gap. | 1. Standard-design current-limiting series gap. | 1. Multi-gap series gap. |
| 2. Single-piece porcelain housings through 312 kv. | 2. Single-column arrangement of elements. | 2. Small, compact size. |
| 3. Single-column arrangement of elements through 48 kv. | 3. Pressure-sensitive, pressure-relief facilities for safety under fault conditions. | 3. Versatile mounting. |
| 4. Triple-column arrangement of elements above 48 kv - increases ability to resist wind and earthquake shock keeps arrester height compatible with other station insulation. | 4. Stacked assembly for all ratings above 36 kv. | 4. Permanently sealed housing. |
| 5. Lowest IR discharge voltages of any arrester. | 5. Sparkover levels, IR discharge voltages and arrester durability compare with station class | 5. Ground isolator operates under fault conditions. |
| 6. Strong grading circuits provide narrow straight-line sparkover response from impulse through switching surges. | 6. Cost more than distribution-class, but only half as much as station-class. | 6. Lowest cost. |
| 7. Pressure-sensitive, pressure-relief system provides complete safety under fault conditions. | 7. Highest rating 120 kv. | 7. Highest rating 37 kv. |
| 8. Durability proved by transmission-line discharge tests. | | |
| 9. Overvoltage interrupting ability for survival under system dynamic overvoltages. | | |
| 10. Adjustable sparkover levels for better system insulation coordination. | | |
| 11. Optional intermediate voltage taps for dual ratings. | | |
| 12. Highest rating 684 kv. | | |

# What makes the Bronco 85 and 88 elbows the industry's safest material handlers?

Going directly to the basic design advantages of the material-handling Bronco elbows, we find the answer to the question in our headline — Holan's constant-radius, upper-arm, actuation system.

With the constant-radius mechanism, your personnel cannot exceed the unit's rated capacity when lifting loads. The basic design of the constant-radius system also lets you add Holan's optional hydraulic safety overload device to eliminate the possibility of moving a load into an unsafe position without the operator's knowledge. For these two reasons, you can be sure your crews are working safely overhead in equipment designed to handle men and material when you specify a material-handling Bronco elbow.

Looking at the constant-radius mechanism further, we see it works on a very simple principle. Assume you have a spool around which you've wrapped a continuous loop of rope, as shown in Figure 1. If the man illustrated is the power source, he pulls on the rope to produce torque output at the spool. To produce a certain amount of torque to do a specific amount of work, the man exerts an exact amount of force through the loop of rope. Since the spool's radius remains constant, the man's effort goes through a constant-size lever arm, giving the man-rope-spool combination a constant mechanical advantage.

Comparing the simple man-rope-spool combination directly with the constant-radius mechanism of the material-handling Bronco elbows in Figure 2, we see the lift cylinders as the power source, the cable loop replacing the rope, and the constant-radius spool serving as the lever at the arm joint. Like the man-rope-spool combination, the output of the constant-radius machine depends upon the output of the power source through the constant lever. If we, therefore, limit the output of the cylinders, we have a defined maximum potential output of the constant-radius mechanism through the upper arm.

To establish the maximum safe output of the machine, we establish the safe lifting capability of the upper arm in the flat-out position. The specific load is multiplied times the distance to the fulcrum — the arm joint — to find the total work required to lift it. We then establish what operating pressure through the constant-radius spool will lift this load, then establish that pressure as the maximum output of the lift cylinders. Loads in excess of the maximum then will require more pressure from the lift cylinders than they are capable of exerting, cutting in the bypass valves and preventing the load from being lifted.

As the upper arm is raised, its capability to handle heavier loads increases, while the straight-line distance from the load to a perpendicular line drawn through the fulcrum decreases. The reduced distance through which the load must be lifted results in a drop in the demand on the constant-radius mechanism; therefore, the mechanism may lift heavier loads as the arm moves up. The specific amount of increased lifting capacity is directly proportional to the increased lifting capability of the upper arm. Throughout the unit's working range, the total output of the constant-radius mechanism remains equal to the rated arm-lifting capability times the distance to the fulcrum centerline. A load in excess of rating will not be lifted, because of the built-in limiting bypass valve within the hydraulic system.

In Figure 3, we see the difference between the constant-radius mechanism and the regular linkage-type machine. As the upper arm is raised, the effective lever arm of the constant-radius unit remains constant; but with the linkage mechanism, the effective lever arm — the distance to the centerline of the acting link — increases to give the system an increasing mechanical advantage. As you move up, therefore, maximum cylinder pressure may not be required to lift the rated load, giving you unsafe reserve lifting capacity. Figure 4 illustrates a direct comparison of the actual lift capacities of a linkage machine versus a constant-radius unit.

In addition, Holan's constant-radius mechanism lets you add a simple hydraulic overload device to prevent movement of a rated load at one position into an unsafe lower position. This device is installed between the pump and regulating valves to sense the cylinder pressure. If pressure rises to an unsafe level, the overload device dumps the system back to the reservoir — stopping and holding the elbow in position until an override control is activated and the unit moved out of trouble.

With the linkage-type mechanism, the varying radius characteristics of the machine make it extremely complicated to develop an overload device. Such a device would not only have to sense pressure, but know what position the arm was in to determine what the correct maximum pressure should be.

While this explanation is brief, it outlines why the material-handling Bronco elbows are the safest in the industry. If you would like an audio-visual demonstration of the comparison between the constant-radius and linkage-type mechanisms, contact your Holan representative. He'll be glad to show you the slide film entitled "A Straight-From-The-Elbow Look at Holan's Constant-Radius Mechanism." Also ask him for O-B Holan publication 1780-HO, which details the contents of the film.

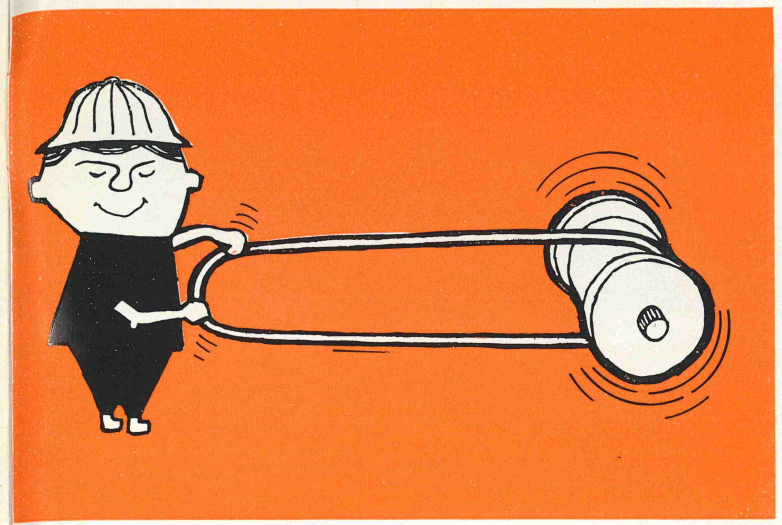


Figure 1 — A simplified version of the constant-radius mechanism would consist of a spool around which you've wrapped a continuous loop of rope. As long as the force applied by the man remained constant, the torque output of the system would remain constant too.

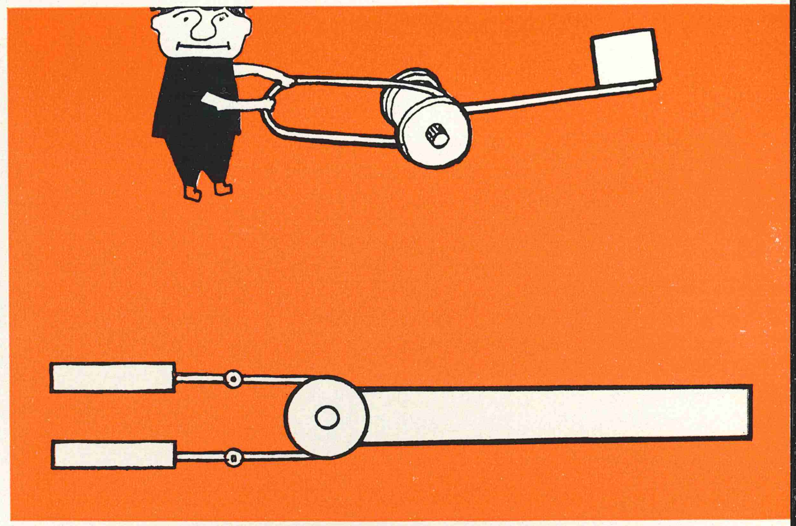


Figure 2 — Replacing the man-rope-spool combination with Holan's constant -radius mechanism, we see that the lift cylinders act on the constant-radius spool to produce a defined output potential for lifting loads on the upper arm.

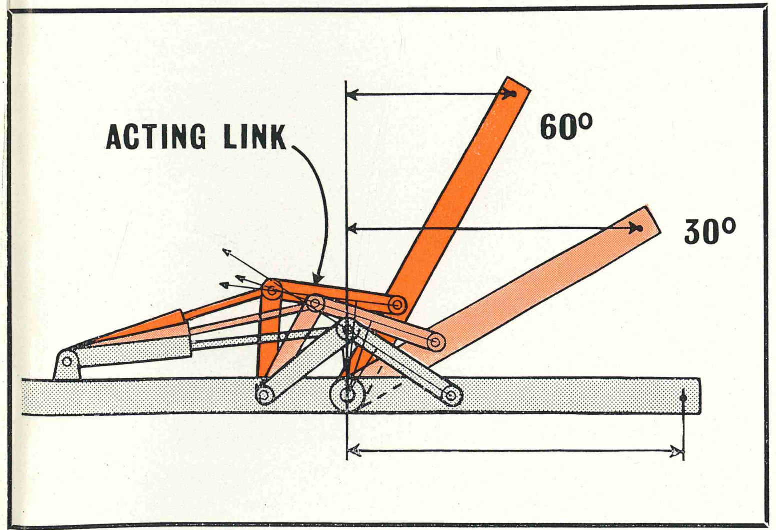



Figure 3 — With a linkage mechanism, the effective lever arm — the distance to the centerline of the acting link — increases as the upper arm is raised — giving the lift cylinders a greater mechanical advantage and unsafe reserve lifting capacity.

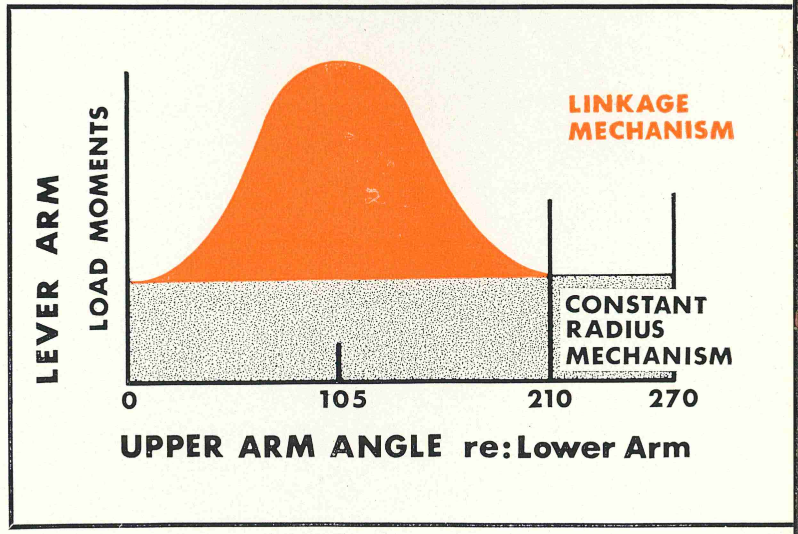
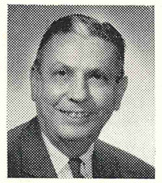



Figure 4 — Here's a comparison of the constant-radius and linkage-type mechanisms' lever arms — both start out the same size, but the linkage achieves a size twice that of the consistent constant-radius unit. Note also the constant-radius mechanism permits 270-degree upper-arm actuation.

**OHIO BRASS MANAGEMENT REPORT**

# Consider how to get "unlost" from the crowd

**BY ROGER A. BLACK**
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY

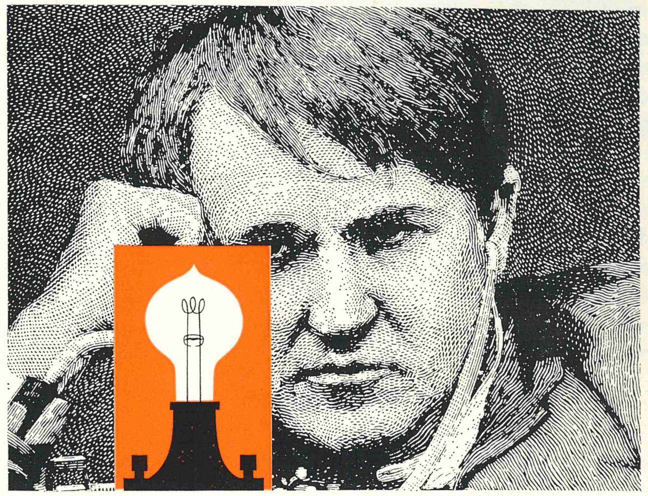


The advertising agency which pioneered the "brainstorming" approach to problem-solving and idea-creation has abandoned the technique. It has concluded that workable solutions and ideas come from individual efforts, not from brainstorming committees.

**THE NEWS** will hardly thrill the ghosts of Thomas Edison, Michael Faraday, and Henry Ford, but they will be glad we have rediscovered the importance of individual efforts. Even more reassured should be people who say they are lost in the crowd, or committee, and have no identity.

**FOR THOSE WHO** really want to leave the crowd . . . to develop leadership, to create ideas, to do first-class work . . . a simple guideline may be found in the recent writings of a Cleveland "paragrapher" who said that "doing first-class work is a lonely job." There's a certain comfort in going with the crowd and more than a little discomfort in acting on your own.

**TIMES LIKE THESE** of comparative prosperity offer special opportunities for the individual to distin-



guish himself. With many orders available, the salesman who goes after every order as though it were the only one is bound to stand out from his complacent brothers. And he will be preparing himself for the day when orders are scarce. You can add to the list of potential standouts the customer-service man who continues to worry about individual customer problems . . . the engineer who refuses to be satisfied with a product that's good enough . . . the inspector who insists that quality is still important . . . the telephone operator who keeps the smile in her voice. They will always stand out from the crowd. Even in their loneliness they benefit themselves and their companies.

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Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario, Canada

OHIO BRASS

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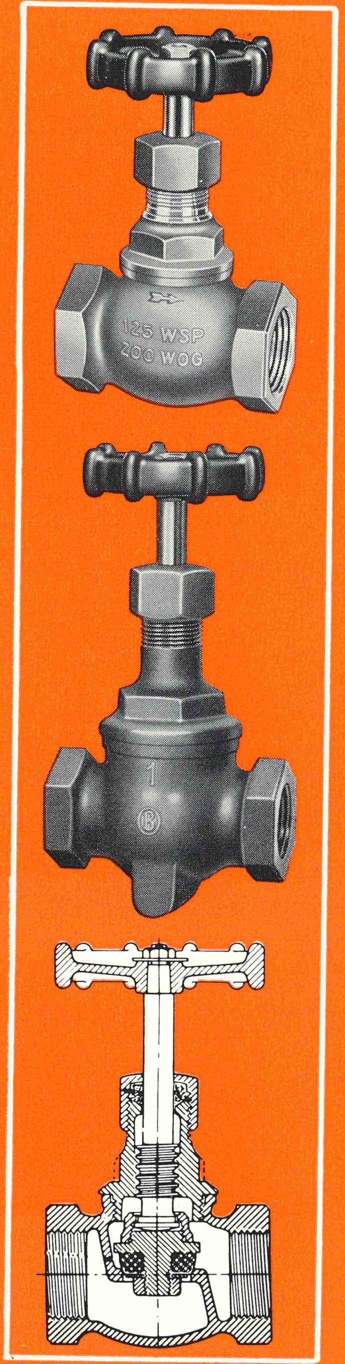
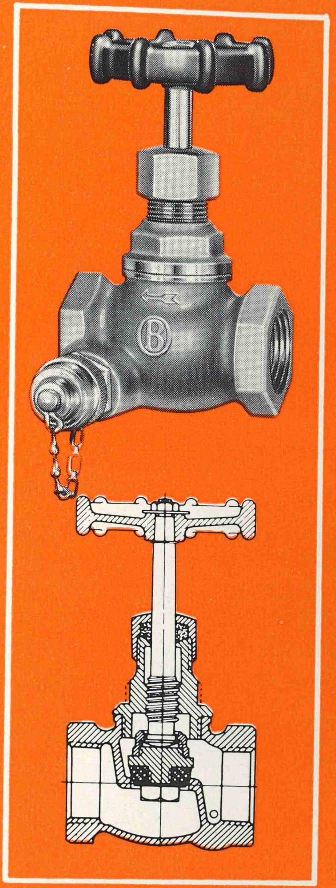
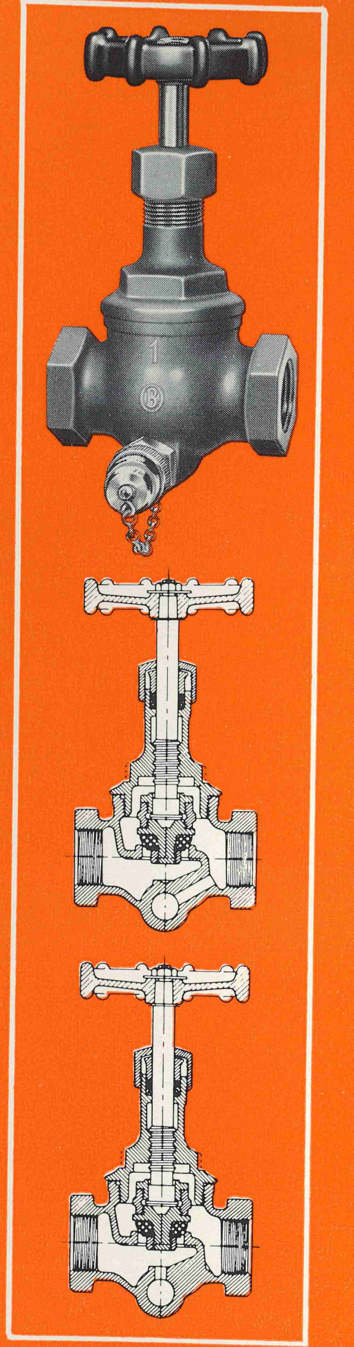
# Hi-Tension News

AUGUST 1967

# It's not so strange that O-B should make electrical apparatus valves







Following conventional globe valve design, for medium-duty service, is Number 1851. This is the first of the O-B apparatus valve line embodying a permanent special sampling device. Sample is drawn beyond shut-off, requiring valve to be open. Sizes: 1 and 2 inches.

◀ For light duty, non-sampling service, the model at the top, similar to the conventional globe valve, is supplied. All premium features of O-B apparatus valves are included. The type is identified as 101-ND. Similar construction is available in an angle valve, 102-ND. Below this is a special globe valve for heavier service, with a blind boss provided on the body. This boss may be drilled and tapped for a sampling plug. In such a case, the sample is drawn ahead of shut-off. The valve is identified as 1001-ND. An angle equivalent of this valve is identified as 1002-ND, supplied without the blind boss. All types are available in the following sizes: ½, ¾, 1, 1-¼, 1-½, and 2 inches.

Heavy-duty globe design is offered in two types. Number 1811 draws the sample beyond shut-off, requiring the valve to be open. Number 1813 draws the sample ahead of shut-off with the valve closed. Both types may be obtained with a permanent sampling device as shown. Sizes: ¾, 1, 1-½, 2, and 3 inches.

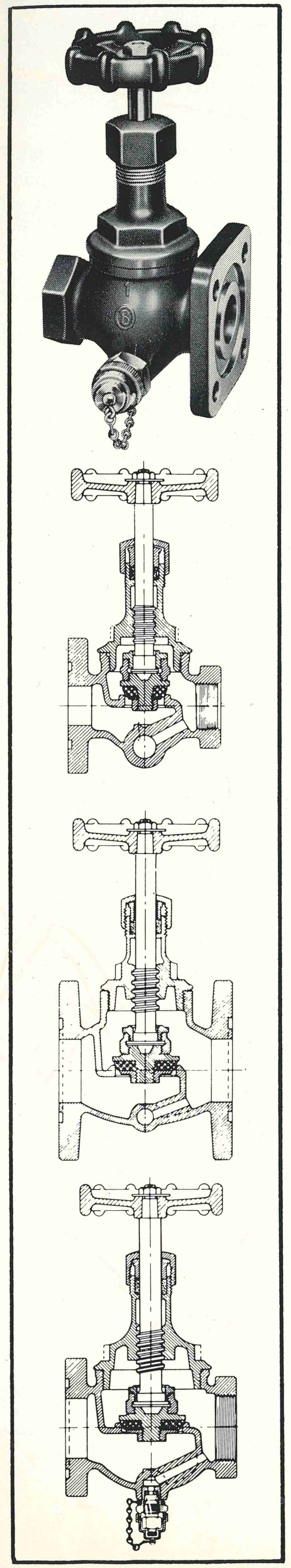
**Hi-Tension News**

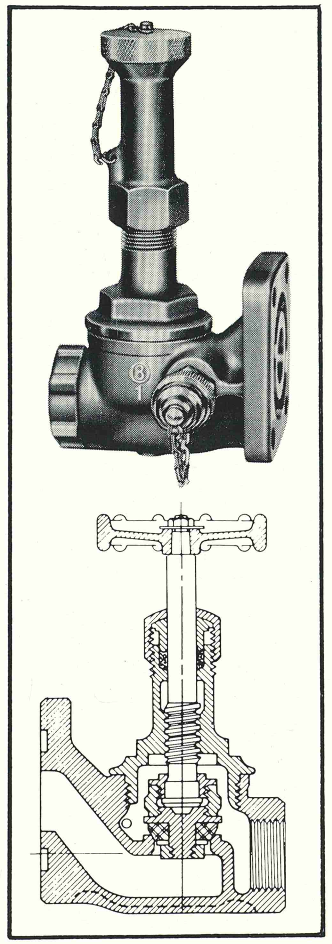
Aug. 1967, Vol. 36, No. 8

**ON THE COVER:** Applying the "made in Newell" sticker to a shipment leaving O-B's new insulator plant. You will see this tangible proof of increased production showing up in your storeroom with increasing frequency. See page 9.

**THE OHIO BRASS COMPANY**

**Mansfield, Ohio 44902**





Special design to permit complete drainage of the tank. Sampler is beyond shut-off, requiring valve to be open. Four minor variations come under the 1940 series. Sizes: 1, 1-½, and 2 inches. In the upper illustration is shown the lock shield, as a substitute for the regular handwheel, available on certain valves. A knurled screw cap exposes the recessed square end of the valve stem, requiring a socket key to operate. Purpose of the shield is to discourage tampering.

◀ Flange attachment to the tank is popular with much station apparatus. Three basically similar valves are shown here. On the top, six minor variations are available under the 1900 series. Sizes: ¾, 1, 1-¼, 1-½, and 2 inches. Center is the 1920 series with four variations, and in sizes: 1, 2, and 3 inch. The lower drawing illustrates a model with sampler on the bottom, 2-inch size only, under Number 1931. All valves illustrated draw the sample beyond shut-off, requiring the valve to be open.

NOTE: In descriptions of the two foregoing valves, reference is made to variations. These do not relate to the basic design of the valve, but to certain details such as hole diameter and spacing in the flange and the type of sampling device to be supplied. These questions would be resolved when a particular valve is specified.

## we've been asked to show and describe the various models . . . here they are

Ask the average power man to find a product made by O-B on his transformers or circuit breakers and instinctively he will look into the air to see whose name is on the bushings or lightning arresters. He might also look down. Chances are the drain valve is decorated with an "O-B" monogram.

This really isn't so remarkable, or so completely unrelated as it may seem. By the turn of the century, before O-B ever made a piece of porcelain, we were manufacturers of a line of high-grade bronze valves. That is how the word "brass" found its way into the original company name.

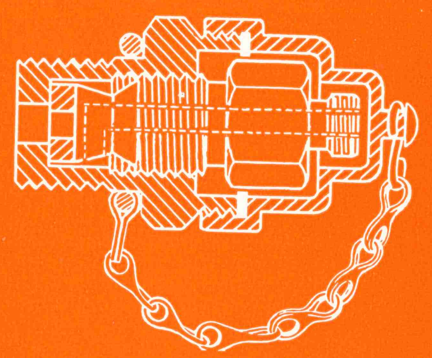
And the step into electrical apparatus valves was also quite logical. Several years ago, drain valves were a serious problem. It was almost impossible to keep them dripless when holding thin, warm, transformer oil. Provisions for taking an oil sample were either primitive or non-existent. It was difficult to get the ordinary valve manufacturer to realize just how important a drain valve could be in the life of a costly transformer.

Last, and most important, our long association with electrical apparatus builders had established lines of communication.

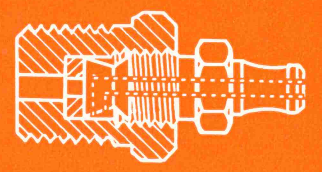
Out of all this has come today's series of O-B apparatus valves, used extensively throughout the industry.

Most apparatus builders regularly furnish O-B drain valves, and sampling devices where specified. But you can be sure of obtaining this equipment by specifying it on your order. If a valve replacement ever becomes necessary, we recommend purchasing it from the apparatus manufacturer to be sure of getting the same combination of

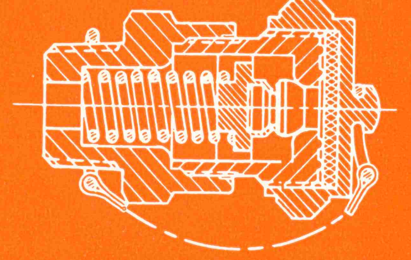
*(Continued on next page)*



Number 5700 sampling device. Removable cap exposes a hex nut which, when backed off, permits flow of oil through a center hole. A 5/16-inch by 32 threaded connection permits attachment of a sampling hose. Light pressure on the nut gives tight shut-off. When not in use, the protective cap assures cleanliness and prevents accidental damage.



A simpler version of a sampling device is Number 5710. Slip connection for a sampling tube remains exposed while not in use. A light turn on the hex nut opens and closes the sealing disc.



Where maximum security is desired, request sampling device Number 5750. The Teflon sealing disc is held in closed position by spring pressure. To draw a sample, the protective cap is removed and an operating cap is screwed in its place. This cap embodies connections for sampling tubes. As the cap is tightened, a plunger depresses the end of the stem and permits oil flow. A choice of operating caps is available, to adapt to individual sampling practices.

*(Continued from previous page)*

features that was originally supplied. The item can also be bought direct from O-B, in which case a complete description is necessary.

If you want to discuss valves, your first point of contact would be your regular O-B electrical district manager. He is well educated in the valve business. But, better to serve your need, he may refer you to the specialized O-B valve factory representative who operates in the same territory. In any case, it is easy to get straight answers to your valve problems. For descriptive literature, write for the O-B electrical apparatus valve catalog Number 46.

In progressing through this series of apparatus valves, a few features should be noted. In all cases, shut-off discs are made of molded Nylon. This material, while relatively hard, is highly elastic. It will conform to the slightest irregularity in the seat that might be caused by a piece of trapped dirt or grit, yet will not be permanently marked by a foreign particle. It makes an exceptionally tight closure that will restrain oil without abusive force on the handwheel. Furthermore, it is practically everlasting.

Special Teflon-impregnated asbestos is used for stem packing. A follower gland keeps the packing tightly and evenly compressed around the valve stem. Leaks are effectively prevented without the necessity for making the stem difficult to turn. The packing material is self-lubricating for longtime smooth operation.

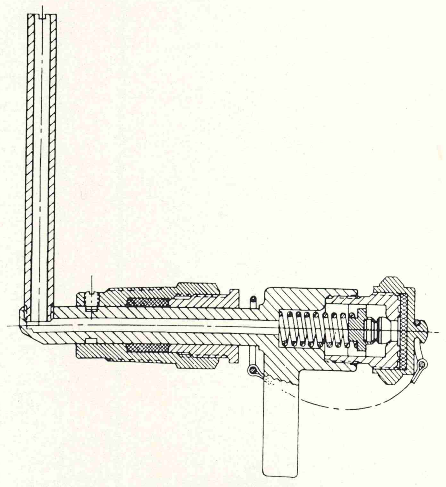
Bodies and disc holders are made of cast bronze, 85-5-5-5, meeting ASTM Standard B62. The support is free to swivel on the end of the stem in order to get perfect alignment of disc and seat. Stems are high-strength silicon bronze according to ASTM Standard B198. All threading is sharply cut and inspected to close-tolerance fit. The over-all valve, equipped with sampling device, meets NEMA Standards.

In accordance with general industry practice, most types of drain valves have sampling ports located beyond the point of shut-off, requiring the valve to be opened before an oil sample can be drawn. An exception to this will be noted in two of the models shown here, where sampling is ahead of shut-off.

More specific details will be covered in the brief discussions under the illustrations.

Speaking as a manufacturer who sincerely wants his product to perform properly, we wish to make two points: First, nylon discs do not require a circus strong man to shut off. A firm twist on the wheel will compress the disc and do just as much good as the old time rule of "all the way and half a turn more." All parts of the valve will last longer and work better if not unnecessarily strained. Secondly, while a valve may be handy to step on or tie ropes to, it is not made to take excessive bending loads. Especially in smaller sizes it should not be asked to bear heavy weights. It is a precision device and should be treated as such.

O-B apparatus valves are made with the full intent of lasting, and giving trouble-free performance, for the life of the equipment on which they are installed. With reasonable handling they will meet this objective.



Special sampling device Number 5755. By means of an external handle, the stem may be rotated so that the explorer tube can assume any angle. This permits accurate measurement of oil level, or may be used to draw samples from the surface of the oil, or from a specific depth below the surface. Regularly supplied with a 4-inch explorer tube, but other tube lengths may be specified.

# Unless it's made strictly to EEI-NEMA specs - - - you may need three hands to do the job!

## Multirester's crossarm hanger has provision for captive bolt to simplify pole-top installations

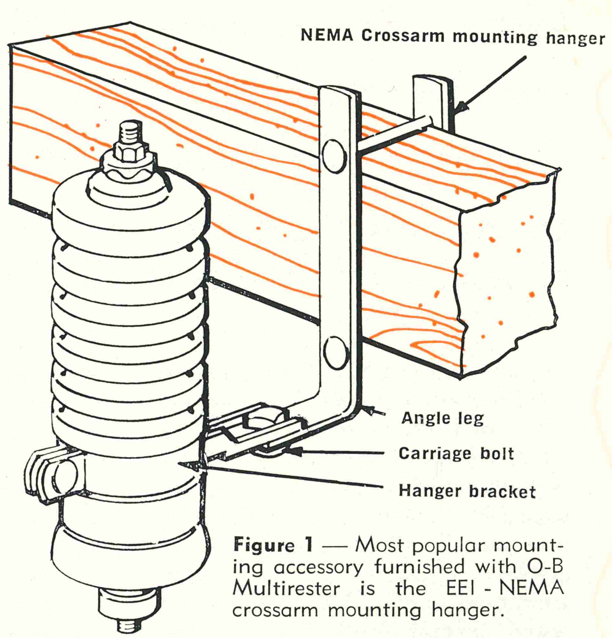



**Figure 1** — Most popular mounting accessory furnished with O-B Multirester is the EEI-NEMA crossarm mounting hanger.

One of the most popular accessory items O-B furnishes with Multirester distribution-class lightning arresters is the EEI-NEMA crossarm mounting hanger illustrated in Figure 1. It is used on all sizes of Multiresters in conjunction with O-B's 71259 and 94855 hanger brackets to provide sturdy and easily assembled mounting facilities on pole-top crossarms as shown in Figures 2 and 3.

EEI-NEMA crossarm mounting hangers are shipped dismantled, and normal practice is to partially assemble the unit before raising it to the crossarm height. It is during this pre-assembly operation that special attention is called to the apparent mismatch of the bolt to the bracket angle. The bolt has a square shank, while the hole in the angle iron is more round than square.

This design feature is intentional rather than accidental. EEI-NEMA standards specify that the bolt coming through the hole in the angle leg of one bracket is to be captive, so that when the arrester and its clamping band is placed down upon it, one hand can be used to support the arrester in its position, while the other hand is free to assemble the nut and lockwasher.

It is for this reason the carriage bolt furnished does not slip easily into the hole in the angle leg; it has to be driven into its position and thus becomes captive to permit simplication of the subsequent assembly operation.

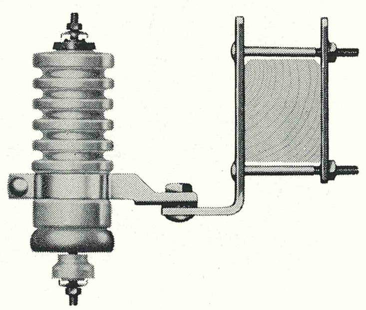


**Figure 2** — Hanger bracket 71259 is used with EEI-NEMA crossarm mounting hanger 89604 to mount Multiresters from 3- through 20-kv rating.

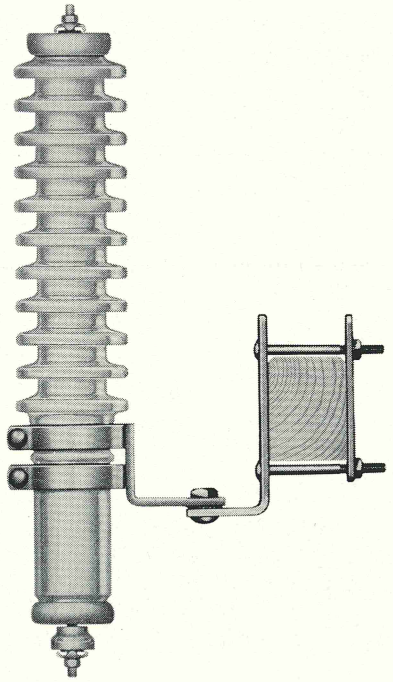


**Figure 3** — Hanger bracket 94855 is used with EEI-NEMA crossarm mounting bracket 89604 to mount Multiresters from 27- through 37-kv rating.

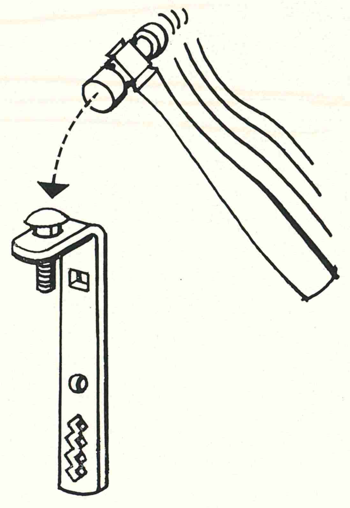


**Figure 4** — The square-shanked carriage bolt must be driven into the hole provided in the angle leg, which makes it a captive assembly and simplifies subsequent mounting.

# Holan's Bronco 89 performance capability proved in the field

## Utility crews put Bronco 89-36-3 through it's paces on actual maintenance work

Design and development testing, quality-control checks, engineering tests, and final inspection procedures all help insure the reliability of a new elbow, but the first real tests begin when the new unit goes into service. Here's where it must deliver — day after day — with maximum safety. That's why Holan asked several utilities to put the new Bronco 89 to work on their systems with their crews. The photographs on these pages illustrate one utility's use of the Bronco 89-36-3 — 41-foot working-height unit with fiberglass upper arm, bucket, and lower-arm insert.

Since the crews were familiar with aerial equipment, the Holan equipment demonstrator needed to give only a brief introduction to the Bronco 89. He explained the 215-degree upper-arm actuation, rated material-handling capability at various angles, and the advantages of the fiberglass insert in the lower arm to make sure the linemen could make maximum use of the Bronco 89.

With a good general knowledge of the new Bronco 89, the crew drove it to the job site. The scheduled work involved setting and rigging a new 65-foot pole at the existing midspan to carry one three-phase 69-kv circuit and one three-phase 23.5-kv circuit over a new distribution line entering an industrial plant addition. The 69-kv circuit would be killed, but the 23.5-kv line would be worked hot since it was the primary feeder to a distribution substation.

To assure clearance for the pole-setting operation, the 23.5-kv circuit was floated away from the proposed pole position. The Bronco 89 easily lifted the lineman and his link sticks up to the midspan location. All three link sticks were installed, the lines pulled off securely, and then the hole dug for the pole.

Meanwhile, another call came in for the Bronco 89. A ladder truck crew took the Bronco 89 across town to install a new service drop at a home construction site while work continued on the new pole installation. With its compact design and low silhouette, the Bronco 89 travels easily through city traffic.

Arriving at the construction site, the lineman engaged the power take off, climbed into the bucket, and was in working position at the pole in seconds. Since the Bronco 89-36 has no outrigger stabilizer jacks to set, it gets linemen on top the job swiftly. A rigid Z-bar-type base frame transfers all loads through the torsion-bar stabilizer to furnish a safe and stable work platform.

With the service drop installed in a few minutes, it was back to the original job site for the Bronco 89. By this time, the pole was set and the crews were finishing framing of the poletop. The next operation involved raising both circuits up over the proposed distribution line and clamping them to their respective insulator strings.

One man climbed the pole, while a second used the new Bronco 89 to begin the clipping-in operation. The man on the pole installed the top phase of the "cold" 69-kv circuit at the 52-foot level, while the lineman in the Bronco 89 completed installation of the lower two phases of the same circuit. Then, both men started working together on the energized 23.5-kv circuit.

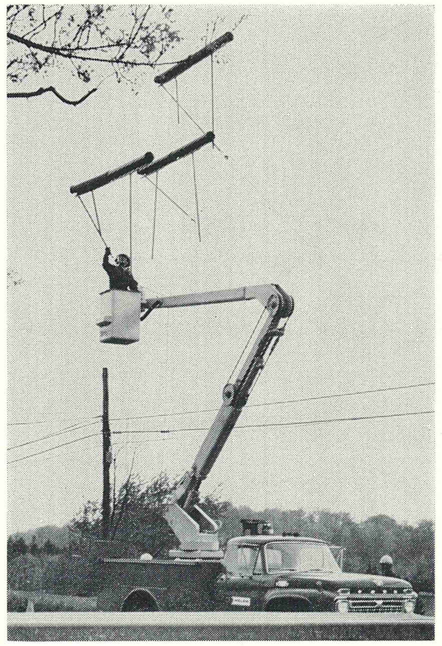
While the man in the Bronco 89's bucket maneuvered over to attach a hot stick, the man on the pole positioned himself to do the final installation of the top phase on the insulator string. The suspension clamp was installed and tightened onto the insulator string by the lineman in the bucket, and a link stick attached to a handline over the static wire at the top of the pole. Groundmen pulled the conductor up to the correct height as the man in the bucket helped position the conductor properly in the horizontal plane. Then, the lineman on the pole inserted the securing pin and cotter to complete the top phase installation. For the next two phases, the man in the Bronco 89 performed the major portion of the installation procedures, receiving aid from the man on the pole.

From the start to finish, the complete job took approximately six hours — including the time the Bronco 89 was away on the service-drop installation. The availability of the Bronco 89 eliminated climbing an adjacent pole to install roller link sticks that would then be slid down the conductor to the proper position and saved an additional man from climbing the pole to assist with the clipping in. The bucket also enabled one man to get closer and into a better relative position to the energized 23.5-kv circuit to speed installation of the clamp and positioning of the conductors.

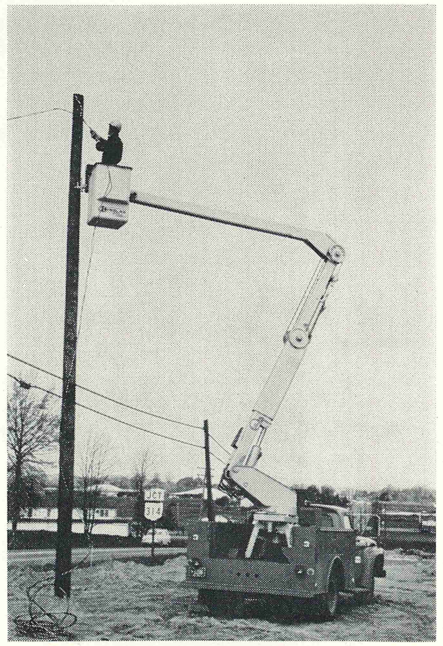
On the second day of the performance trials of the Bronco 89, it was used to convert a distribution line to a higher voltage. The 215-degree upper-arm actuation permitted the linemen to pivot over center and come up from the field side of the system. During the day, no poles had to be climbed. Transformer switching was fast, since no outriggers had to be set. The Bronco 89's working height of 41 feet proved ideal on this 12-kv system where the top phase was approximately 38 feet off the ground. The Bronco 89's lifting strength proved handy for carrying tools, insulators, and hardware to the poletop — even though loads remained well below capacity.

Looking specifically at the capabilities of the Bronco 89, both the 36- and 41-foot bucket-height models offer a bareshaft material-handling capability of 300 pounds in all positions, and up to 1,000 pounds when the upper arm is elevated above 75 degrees. The pedestal rotates continuously 360 degrees, while the lower arm pivots 90 degrees from the horizontal. The upper arm actuates 215 degrees relative to the lower arm. Because it uses Holan's constant-radius upper-arm actuation mechanism, a fully hydraulic safety overload device may be added to assure maximum safety when handling material loads. Fiberglass upper arm and bucket are standard on the Bronco 89, but the fiberglass lower-arm insert is optional. The rugged Z-type base frame and integral torsion-bar stabilizer keep the Bronco 89-36 on even keel, while the 89-41 requires outrigger jacks for maximum stability at the higher working heights.

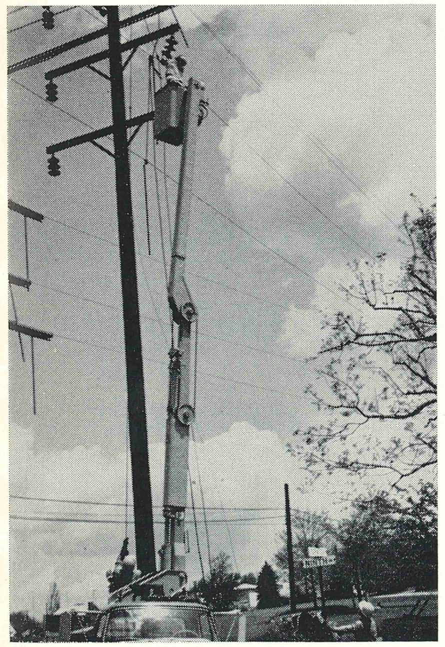
For additional information on the performance-proved Bronco 89 — or a demonstration — call your Holan representative. He'll give you full details on standard equipment, options, and the many applications of the new Bronco 89 whether you select CORA or CBOC mounting. Or, write: Holan, Division of The Ohio Brass Company, 4100 W. 150th St., Cleveland, Ohio 44135.



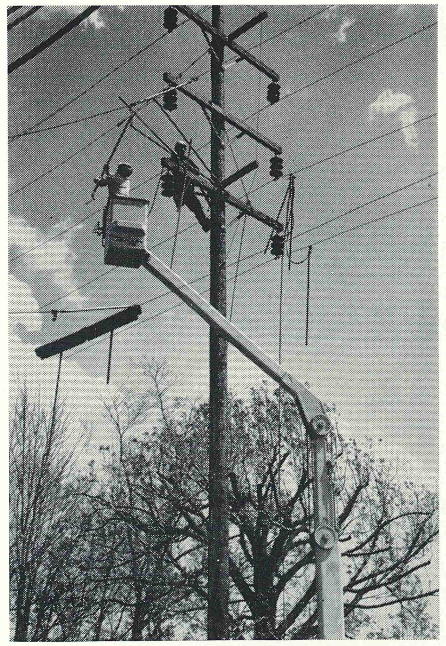
To provide clearance for setting the new 65-foot pole, one lineman used the new Bronco 89-36-3 to attach roller link sticks at midspan and float the energized 23.5-kv circuit away.



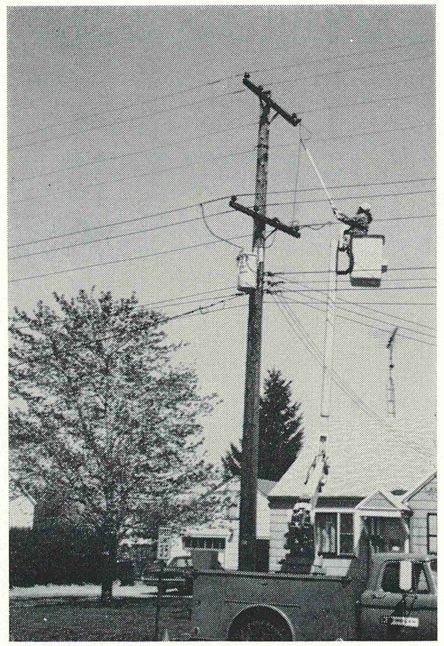
While work proceeded on the pole setting, the Bronco 89 went across town to install a new service drop. Without outrigger jacks to set, a lineman gets up to the pole fast in the 89.



Back at the pole installation, the Bronco 89 was used to clip in the lower two phases of the 69-kv circuit, while a man on the pole installed the top phase.



Working together, the man on the pole and the one in the 89's bucket installed the top phase of the energized 23.5-kv circuit. Then, the lineman in the 89 finished clipping in the lower two phases, assisted by the man on the pole.



The Bronco 89's 215-degree upper-arm actuation permitted linemen to go over center and go below underbuild to reach the field side of this distribution system during upgrading.

Part of the assembly line at the new O-B plant at Newell, West Virginia. Continuous production of 6-inch and 4¼-inch distribution deadend insulators, in sizable volume, has resulted in a "stock" status for shipments.

# Distribution deadend insulators can now be shipped from stock

## First major relief of insulator shortage resulting from Newell production

Impact of increased production from O-B's new plant facilities at Newell, West Virginia, is dramatically illustrated in the change that has occurred in availability of 6- and 4¼-inch deadend insulators for distribution service. As long as these units shared many production facilities with larger suspension insulators for transmission lines, shortages that were acute in both types could not be remedied at the same time.

By transferring small insulator production to Newell, we have been able to achieve continuous output, assuring a steady flow in sizable volume.

A year ago, deliveries on the 6- and 4¼-inch units were extended far into the future, and were creating many cases of real hardship. Today, this backlog has been absorbed and these insulators have become stock items.

Both sizes are being produced in the new ASA blue-green glaze, designated by O-B as "Skytone." Usage has gone so completely in this direction in recent months that the chocolate brown glaze has been put into the special order category . . . available only on specification.

Requirements for O-B distribution deadend insulators may be entered direct on the factory, or through the Graybar Electric Company, whichever is your customary buying practice. Orders can be shipped from stock.



MANUFACTURED AT THE
NEWELL, W.VA., PLANT
OF THE OHIO BRASS COMPANY

# . . . proof that O-B is doing something about insulator shortages

Look in your stores. Do you see any recent O-B shipments containing this sticker? If not, you soon will. A month ago we started applying them to all pieces leaving our Newell, West Virginia plant. This is being done to emphasize that O-B's expanded insulator production facilities are more than promises.

Erecting and equipping new factory buildings, then locating and training competent production personnel, is a tedious, time-consuming process. It is not an immediate answer to an immediate scarcity. O-B had the good fortune to find a better expedient at Newell . . . a spacious plant, in good condition and ready for occupancy, and built for ceramic manufacture . . . containing a high capacity continuous tunnel kiln in first-class operating order . . . and in a community almost exclusively devoted to ceramic production, where the skills of this trade are familiar.

The trickle of production that started only a few weeks after we occupied this plant has increased steadily within the first year, and is progressing at an ever-quickening pace as deliveries of new machinery are being completed. The kiln is in production. This fact, alone, represents a saving of a year or more in getting a new plant on the line. The most serious bottleneck in expansion plans, kiln capacity, is "in the clear."

Simply to remind you that O-B HAS DONE SOMETHING about insulator shipments, a sticker stating, "Manufactured at the Newell, West Virginia, plant of The Ohio Brass Company" will be placed on every package. When you see it you will know that this is new production . . . the kind of action that counts in a period of insulator shortage.

Crates and cartons containing O-B materials manufactured at the Newell, West Virginia plant are now identified by this prominent label. Its purpose is to emphasize the effect this new facility is having on O-B production, and on the relief of the present insulator shortage. Look for this label on new shipments coming into your stores. It will be tangible proof of our expanded manufacturing facilities.

# Duty cycle test in high voltage lab demonstrates remarkable capability of Dynagap 5's interrupting operation

Dynagap 5 station-class lightning arresters have demonstrated superb interruptive capabilities under the comprehensive duty-cycle-test conditions imposed by the engineers of O-B's High Voltage Laboratory. An impressive number of exacting trials have been conducted to document the interruptive characteristics announced in the Dynagap 5 duty-cycle-design tests.

The duty-cycle test used throughout the industry is outlined in USA Standard C-62.1. It calls for the application of 60-cycle rated voltage to the arrester and then superimposing upon this voltage a series of twenty 10 x 20 microsecond impulse waves of 10,000 amperes.

A photograph of the oscillogram of the interrupting operation is illustrated in Figure 1. This test record of Dynagap 5 duty-cycle performance also includes the measurement of power-follow current under the conditions of the test. Successful evaluation of an arrester under duty-cycle testing is based on a comparison of the physical condition and electrical characteristics of the specimen arrester before and after being subjected to the series of prescribed operating cycles. In documenting duty-cycle-test results, proof of interrupting capability is normally provided by comparing photographs of oscillograms made of the first and twentieth trials, and including oscillograms of the associated 10-ka discharge-current and power-frequency sparkover tests made before and after the duty-cycle-test series.

O-B's laboratory staff has significantly expanded the Dynagap 5 duty-cycle-test procedure to include an additional series of trials not prescribed by USA Standard C-62.1. In the first and required series of 20 duty-cycle trials, the initiating impulse is timed to occur at 50 electrical degrees after the 60-cycle-voltage zero, as shown in the oscillograms of the first and twentieth operations in Figure 2. In the second series, which consists of 10 trials and is illustrated in Figure 3, the impulse is timed to occur 90 degrees after system-voltage zero.

This means that the first test series is conducted with the superimposed impulse occurring just before maximum system voltage is reached, while the second series investigates the interruptive action when the impulse occurs just at peak voltage.

Both series of duty-cycle tests made in O-B's High Voltage laboratory indicate maximum consistency in the interrupting action of the Dynagap 5 arresters.

The duty-cycle oscillograms of the Dynagap 5 station arresters further indicate the forceful action by which the arc-generating properties of the improved-design current-limiting gap achieves an abrupt and immediate interruption of power-follow current completely independent of system voltage. The rapidity of Dynagap 5's interrupting action eliminates all danger of high follow current approaching half-cycle duration causing false over-current relay operations. The severe, multiple applications of high-current impulse waves to a station arrester energized at its rated nameplate voltage, in accordance with the provisions of the USA Standard C62.1 duty-cycle test, constitute a comprehensive measure of an important aspect of arrester performance. The test comprises one of several limiting factors in determining the operation of any arrester, but in the case of the non-current-limiting-gap arrester (magnetic or otherwise), it specifically establishes the absolute maximum line-to-ground voltage rating of the arrester.

In arresters prior to the current-limiting gap, successful power-follow current interruption depended on the deionization of the gap atmosphere, the amount of this ionization being directly proportional to the current through the arrester as determined by the arrester's inherent resistance. Fundamental design principle of simple gap arresters lumped the arrester resistance in its valve blocks. Because of their non-linear resistance characteristics, the valve blocks produce greater internal currents when subjected to higher than rated voltages and in turn result in thermal damage to the blocks and ultimate arrester failure.

The current-limiting-gap-design arresters have modified the voltage-limiting aspects of the duty-cycle tests. Interruption of power-follow current is no longer totally dependent upon valve block resistance. Arc voltage generation in the gap itself has now become the dominant factor in controlling arrester current. The power-follow arc is extinguished because insufficient energy is available to sustain its existence, even at higher than nameplate voltages.

While the rated nameplate voltage of a current-limiting-gap arrester is still determined by the USA Standard C62.1 duty-cycle test, it does not necessarily limit the voltage at which the arrester will successfully perform its interrupting function. The duty-cycle test must be integrated with other operating conditions to establish the parameters for optimum application. The current-limiting-gap arrester is the only known design by which satisfactory performance can be obtained during many system dynamic overvoltages, such as those caused by switching operations.

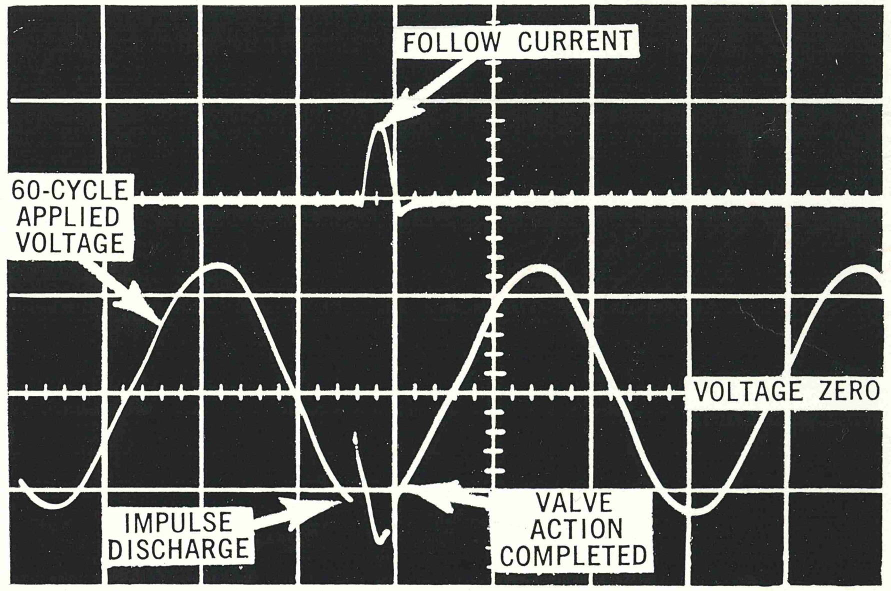
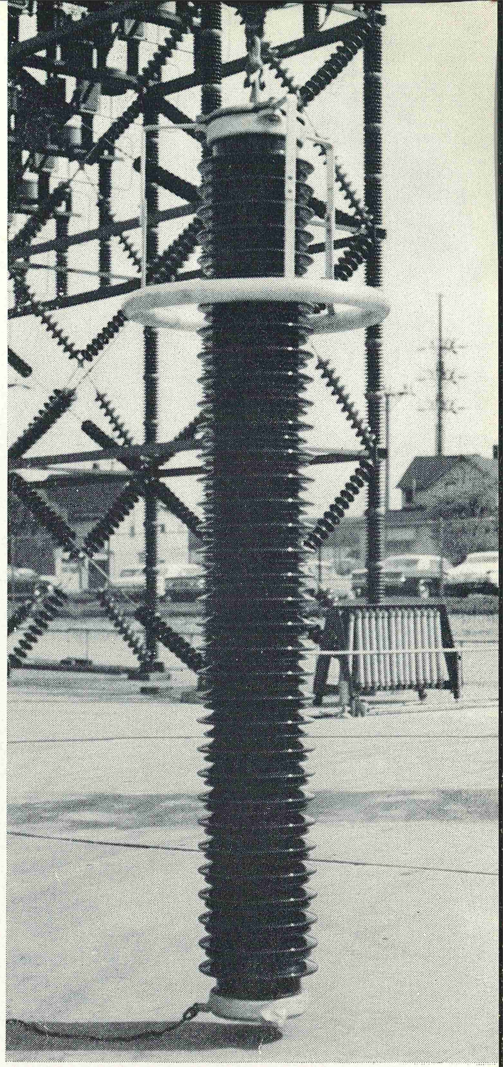
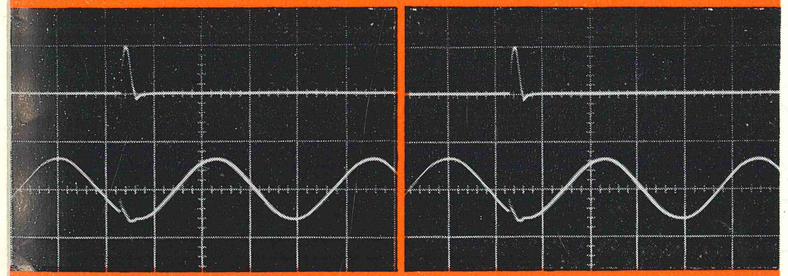


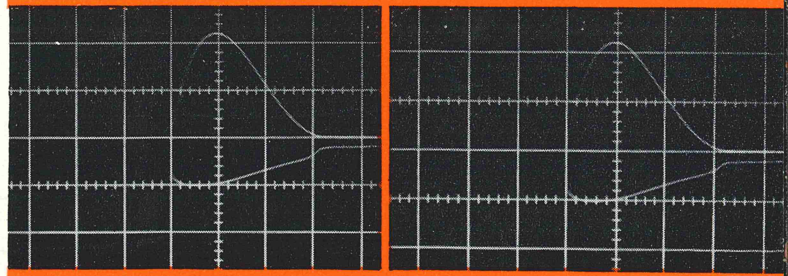

**Figure 1** — Duty-cycle oscillogram for the Dynagap 5 lightning arresters.





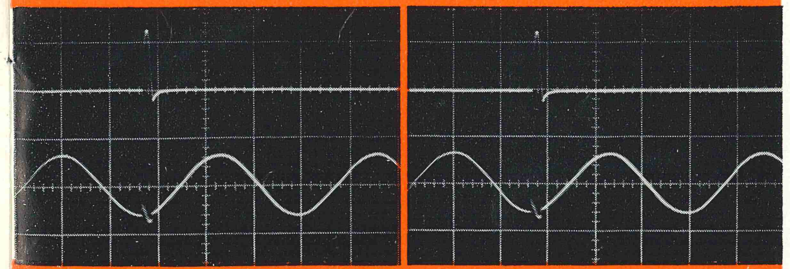
**First Trial** **Twentieth Trial**

**Figure 2** — The first series of 20 duty-cycle trials was performed with the initiating impulse timed at 50 electrical degrees after 60-cycle-voltage zero.



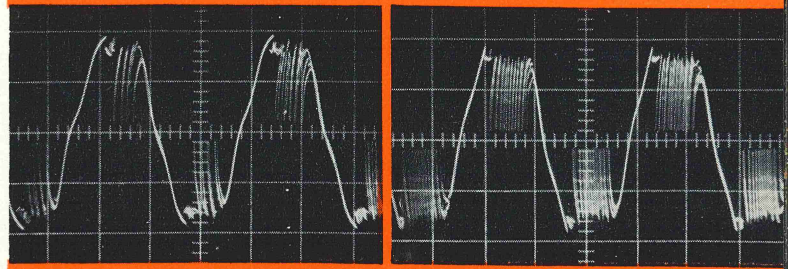
**Before duty-cycle test** **After duty-cycle test**

**Figure 4** — The USA Standard C62.1 test for high-current, short-duration withstand is performed immediately before and after the duty-cycle tests. Any deviation found in comparing the oscillograms would be cause for further investigation.



**Twenty-First Trial** **Thirtieth Trial**

**Figure 3** — The second series of duty-cycle trials was performed with the initiating impulse timed to occur 90 degrees after system-voltage zero.



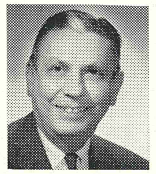
**Before duty-cycle test** **After duty-cycle test**

**Figure 5** — Power-frequency sparkover of the arrester specimen is determined before and after the duty-cycle tests.

OHIO BRASS MANAGEMENT REPORT

# Quality is a word to prove by doing, not by saying

**BY ROGER A. BLACK**
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY

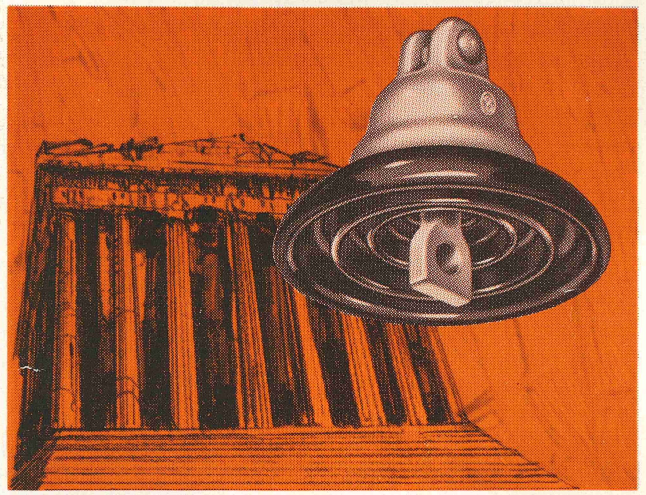


The word "quality" comes at us from every direction a hundred times a day. It would seem that there is a cult dedicated to the proposition that saying "quality" often enough will make it so. We want quality. We want quality homes, quality cars, quality insulators and quality electric service. But how do we know whether there is substance to match the word?

**YOU KNOW HOW** you convince people of the quality of your electric service. We know, I think, how we should proceed to convince electric utilities of the quality of our insulators. First, we would hope to show you rather than tell you that we have quality products. Actually, we should never use the word "quality." We should demonstrate and let the demonstration show you whether there is quality or not.

**OUR BEST DEMONSTRATORS** are the insulators that we have made during the past 60 years. We probably have more in the air than any other manufacturer. For a mass-produced item, the reliability has been amazing.

**SECOND, WE HAVE TRIED** to demonstrate the value of our counsel in addition to our product. This means we have not only had to develop expertness on our own products but expertness on the environment in which they serve and their relationship to other hardware, to conductor, to towers. As utilities have embarked on each advance in extra-high voltage, we have participated in research and testing to develop the best insulator-hardware arrangement for each new voltage level. We hope this is the reason that O-B leads in the number of EHV projects using our insulators and hardware.



**THIRD, WE HAVE SENT** to you as our representatives the most knowledgeable men available . . . including men with many years of development experience and men who have served with utilities and know your problems. Their careers rest on looking out for your best interests. We invite you to test their knowledge and dedication in any way you choose. If these demonstrations are convincing, we should never have to mention "quality." You'll know it's there.

765-H

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OHIO BRASS

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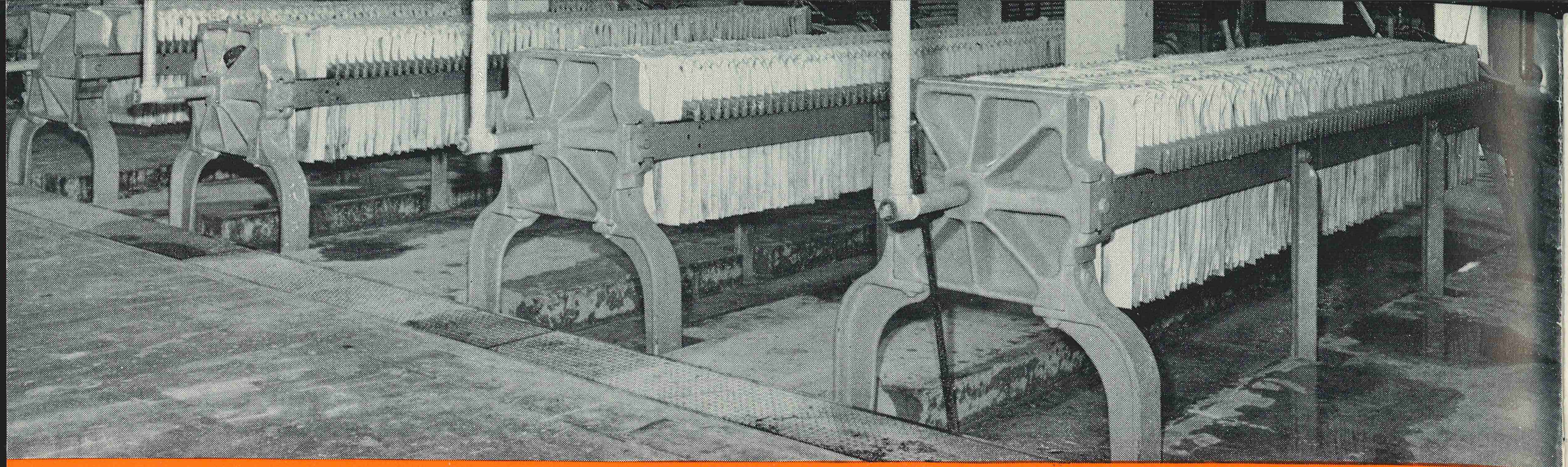
# Hi-Tension News

SEPTEMBER 1967



Part of the presently expanding clay manufacturing department. Filter presses remove surplus water from the creamy clay "slip" and produce press cakes which are the basic material for all future forming operations.

After forming and drying, post insulators are held in storage awaiting final finishing and glazing operations preparatory to firing through the tunnel kiln. This picture is indicative of Newell's present production of posts.

Hi-Tension News
Sept. 1967, Vol. 36, No. 9

ON THE COVER — Graphic proof that the new O-B insulator plant at Newell, West Virginia, is in production. While the factory is capable of any type of insulator manufacture, its facilities are presently concentrated on all kinds and sizes of posts.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

# Only a year's time sees the "Made in Newell" label on O-B shipments

Probably no two suppliers see the present insulator shortage in exactly the same light. Some may get relief by adding extra equipment and hiring more men. Some may find the answer by building onto a few departments. This wasn't the case at O-B's Barberton plant. It was bursting at the seams! It wasn't merely a problem of a few new machines. We had run out of space, and equipment was working beyond estimated capacity. We needed a whole new factory! Plans were in progress for this when we learned of Newell.

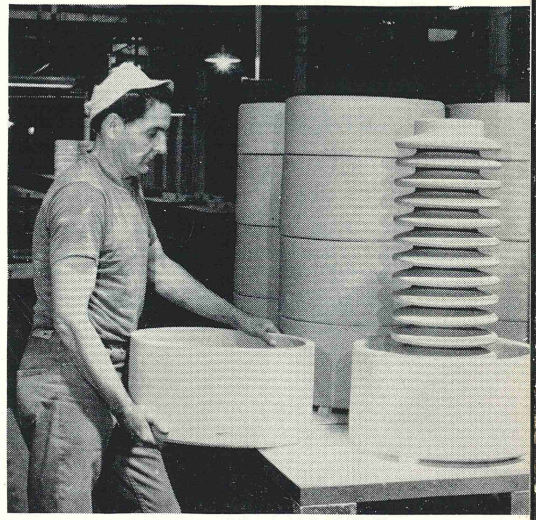
Here was over eight acres of manufacturing space available, clean and in good repair. It was formerly a large pottery and built for ceramic production. It contained an almost priceless asset — two high capacity tunnel kilns in first class order (tunnel kilns are a major investment in construction time and dollars). In short, it represented cutting at least a year or possibly two years off the time it would take to build and organize a new plant. So, our president threw his gold plated ground breaking shovel over the rail of the Newell Bridge into the Ohio River, and O-B leased a ready-made insulator factory in May 1966.

You don't buy custom built clay machinery off-the-shelf. We discovered something almost as hard to get as a suspension insulator. But the first year saw a lot of new equipment delivered and running. More is arriving continually. Insulators, in substantial quantity, made in Newell from the clay bins to the shipping dock, are starting to ease the present shortage. And, as additional production machinery is installed, volume of shipments will increase. This is what we needed . . . a new self-contained, self-supporting operation that could eat into the backlog of delayed shipments and assure reasonable future deliveries.

In addition to Newell's own products, the plant's ample space permitted installation of extra assembly lines to handle some of this work formerly performed at Barberton. In such cases, fired porcelain takes a short truck trip to Newell for final assembly, thereby relieving another serious bottleneck.

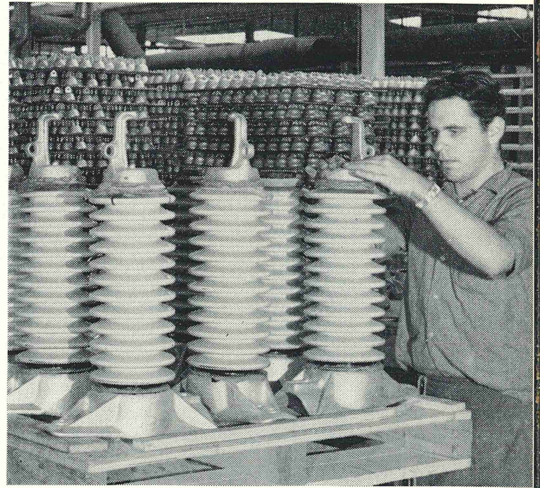
While no insulator shape is beyond Newell's capability, the principle of "first things first" has resulted in the bulk of production being directed toward posts of all types. Concentration on a particular class of product leads to much greater manufacturing efficiency. An indication of post output can be gained from the accompanying pictures.

And, to help you evaluate the impact of Newell production, every container leaving the plant carries a prominent orange and black label reading, "Manufactured at the Newell, W. Va., plant of The Ohio Brass Company." In increasing numbers these marked crates and cartons will be showing up in your storeroom.



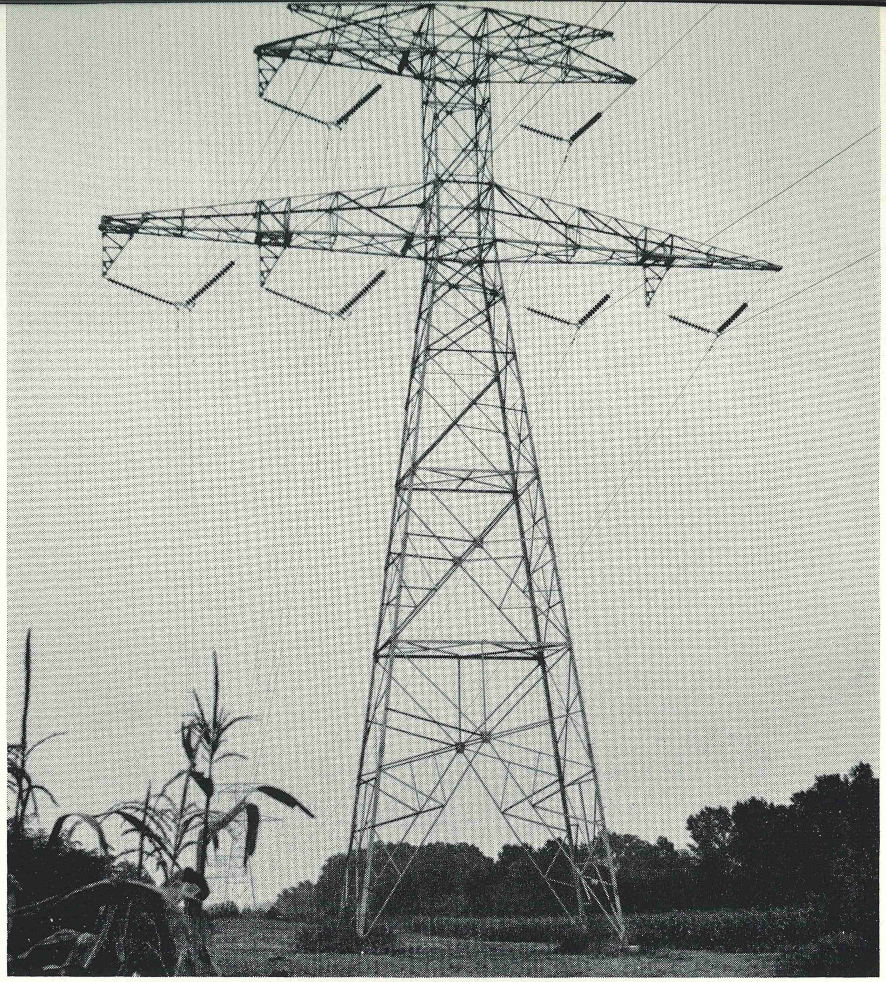
"Placer" loading a car for its trip through the continuous tunnel kiln.

Cement assembly of horizontal line posts. Like the bulk of Newell production, these posts employ the new Skytone glaze.



# Ordering proper extension links is now as simple as ABC

## O-B's easy procedure explained for Engineering and Purchasing Departments



Low angle tower on Union Electric Company's 161-345-kv line clearly illustrates the variety of extension links sometimes required in V-string construction for EHV applications.

It was once the practice to provide detailed listing of extension links in the O-B Catalog. There is now a choice of four different ends which may be used in all combinations. Eyes and clevices can be oriented as needed. After all these mechanical requirements have been met, an unlimited range of lengths is required. A decent listing of links would presently consume several catalog pages, hundreds of numbers, a lot of time to look up, and would promote confusion in ordering that might hold up a whole construction project.

Now, ordering has become a very simple operation. Just tell us what you want. We make the links to order. All "special manufacture" has, in effect, become standard.

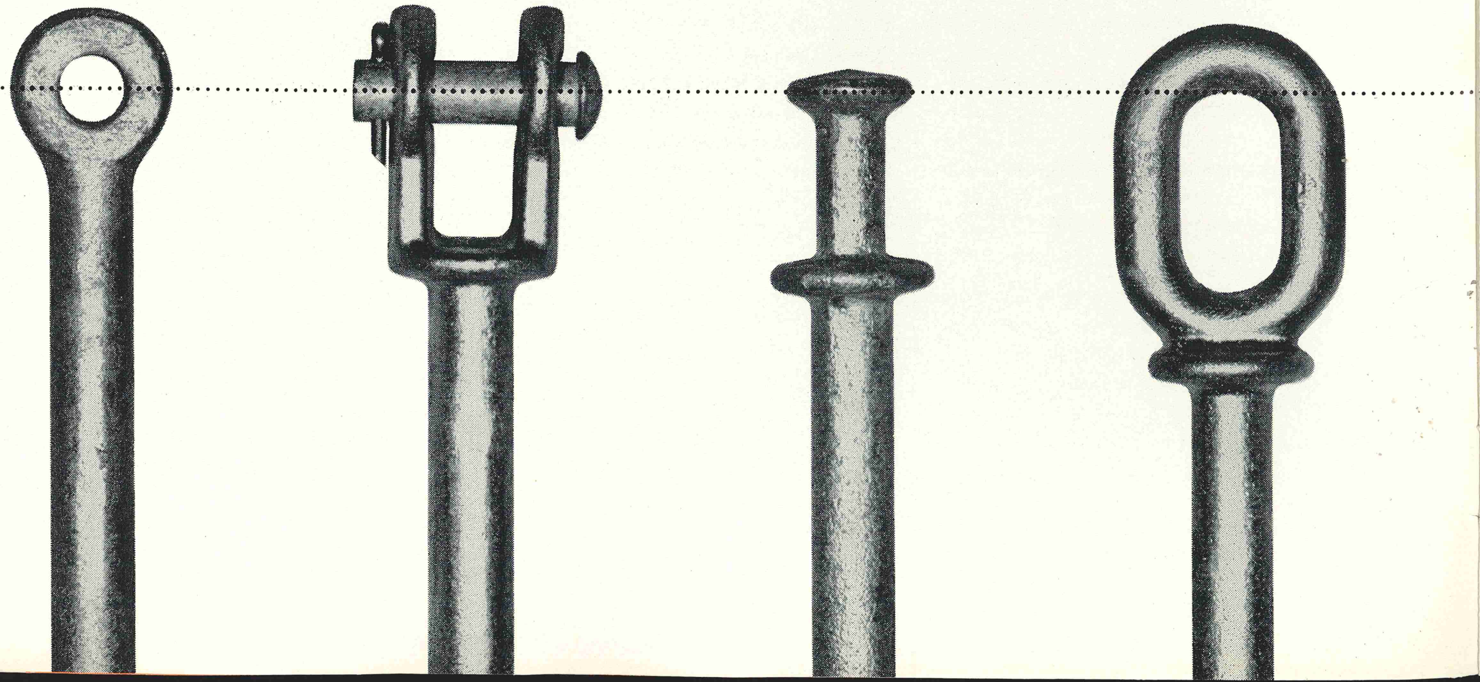
O-B extension links are drop-forged from steel bar stock. Any die can be used for either end. Orientation of ends as specified, and any length within practical limits, are made possible through the use of open end dies.

Ends are described as clevis eye, clevis, ball, or chain eye, in the order illustrated. Except where the ball is specified (it already has 360-degree turning range), fittings can be in line or rotated 90 degrees. Reference to orientation is based on looking straight through the hole, including the chain eye. To specify length, points of measurement are shown by the dotted line. Just tell us what you want. If your length measurement goes below 10 inches we suggest checking with us before ordering, as this can sometimes complicate the production of certain combinations. It's usually not impossible, but a brief discussion may be advisable.

Ball ends are ASA Standard 52-3 as used in conventional ball-socket suspension insulators and equivalent miscellaneous hardware items.

Use of steel bar stock for extension links, plus drop-forging the end fittings, results in strength ratings that can be accepted for the heaviest construction. All links are conservatively rated at 30,000 pounds. This exceeds, by a safe margin, the working strength of associated insulation. If double chain eyes are specified, higher strength ratings are available.

So, the next time you order extension links, don't bother looking for a catalog number. Just give us your specifications. You'll get exactly what you want.



◀ Range of available end fittings for O-B extension links, in order of clevis eye, clevis, ball, and chain eye. Any orientation of ends may be specified. Dotted line indicates measurement points for length, which is optional. Where required, hot line shoulders are included.

# Be sure color is part of your insulator purchasing specifications

## Present wide divergence of preference between USAS C70 gray and brown increases chance of shipping errors

During the present period of various degrees of usage of chocolate-brown color and USAS C70 gray insulator glaze (O-B's designation, Skytone), there is quite an opportunity for confusion in filling orders.

Some utilities want all new orders delivered in the gray color. Others have not yet adopted this practice, and still want the traditional chocolate-brown color. Others build new lines with gray, but maintain existing circuits with brown, therefore keeping a stock of both. Some want their lines in gray, but their stations in brown. In short, there is presently a host of variations in individual requirements.

In almost all instances O-B manufactures insulators in either color, or can if so specified. Since identical insulators are now made in two colors, it is possible that we may have one color in stock while the other color may be several weeks away in production. This can be quite a factor in filling emergency orders. When confronted with this problem, we notify the buyer and he can choose the most important consideration . . . delivery time or color.

Some utilities have filed instructions with us stating that all their insulator requirements be either gray or brown. We are glad to adhere to such an arrangement, but have found it far from foolproof. Occasionally a color in violation of standing instructions is wanted, and no one remembers to note the exception on the order. While the buyer readily takes responsibility for such an error, we would rather send him what he wants than have a good excuse for making a mistake.

Until insulator color gains industry-wide agreement, where it will be safe to take color for granted in filling an order, it would be very much to the buyer's advantage to add "gray glaze" or "chocolate-brown glaze" to other purchasing specifications. If you prefer, this information can be incorporated into the coding that is part of the catalog number. Your O-B district manager will provide the proper information for your purchasing department.

We will be happy to work out any convenient arrangement to get you the insulator color you want. But because preference differs quite widely between buyers, today, it would be mutually helpful if orders were specific in this regard.

# Factors influencing the selection and application of lightning arresters on underground distribution systems

A general analysis of the application of lightning arresters to underground distribution circuits suggests certain guidelines for their selection and location by which the reliability aspects of the system can be improved. The heavier investment in equipment, the higher cost of URD outages, and the greater requirements for service continuity combine to support a recommendation that the quality of arrester protection for URD approach that of small substations.

Upgrading of the lightning arrester protection for underground distribution systems should incorporate increased provisions for discharging overvoltage surges with very heavy current components, which because of their relative infrequency are normally considered a tenable risk in overhead feeder construction. Surge voltages of 100 kv and over generally result from direct lightning strokes and peaks of 500 kv are occasionally reached, but the higher levels of voltage are effectively limited by line insulation flashovers. Currents associated with lightning strokes vary from an average of about 3000 amperes to rare instances where extremes of 100,000 amperes have been reported.

A valid basis for proposing substantial upgrading of lightning arrester protection on underground systems in comparison with that considered acceptable on overhead lines comes from comparing the resultant damage from lightning strokes of equal intensity. Not only are the components of the underground system more expensive, but greater vulnerability is involved, damage is more difficult to repair and even location of the fault may add serious complications.

The two most common types of underground distribution systems are the radial and loop circuits, supplied by overhead feeders which connect the underground installations to the fully protected substations. When a lightning stroke occurs on the overhead feeder line, the resulting surge travels along the line in both directions until it is either reflected or fully attenuated. Effective discharge of such surges at the substation is accomplished by locating lightning arresters as close as possible to equipment which must be protected, with the result that the lightning arrester is often mounted on or adjacent to the distribution transformer.

A simple extension of this principle applied to the other end of the feeder line makes it common practice to mount an arrester on the transition pole at the junction where the overhead feeder line connects to the underground cable. In Figure 1 a conventional radial underground distribution circuit is shown with the arrester mounted on the transition pole, while in Figure 2 a corresponding loop circuit is diagrammed with feeders at each end of the loop and arresters at each of the transition poles. The function of the lightning arrester connected at the junction of the overhead feeder and the underground cable is to intercept and prevent lightning type overvoltage surges which may occur on the overhead feeder from entering the underground system. In performing this operation, the arrester provides a temporary path to ground for the current associated with the lightning surge as well as for the stored energy of the system.

The transition pole arresters constitute the first and most essential step toward protecting the underground system from overvoltage surges. An appraisal of their performance capabilities establishes the degree of protection which can be assured for the underground system. The operating characteristics of the arrester require careful evaluation in respect to sparkover voltage, IR discharge voltages and thermal capacities. Comparison of the protective capabilities of distribution and intermediate class arresters reveals strong advantages in favor of the intermediate arrester, particularly in respect to its much lower values for IR discharge voltages, its capacity for the discharge of heavy currents, its greater immunity to exterior contamination, and the increased reliability inherent to its more sophisticated interruptive gap. Even greater advantages can be obtained with corresponding station class arresters which furnish "premium grade" characteristics in all protective categories.

The reason IR discharge voltage levels of the transition pole arresters are an important factor in protecting underground systems involves a basic consideration of the system's surge impedances. By definition the surge impedance of a power line is the instantaneous relationship between surge voltages and currents expressed in ohms, and is a constant for any given line dependent on line geometry and dielectric constant. Surge impedance, for example, of a typical overhead phase conductor of bare No. 2 stranded wire averaging 30 feet above the ground can be calculated to be 510 ohms, while a corresponding URD cable having No. 2 stranded wire with 0.220 cross-linked polyethylene insulation has a surge impedance of 30 ohms. Surge impedance of a distribution transformer may range from 1000 to 4000 ohms.

Whenever a substantial difference in surge impedance occurs along a continuous circuit of appreciable length, a reflection point for traveling waves is established. For example, when the overhead feeder line with a surge impedance of 510 ohms, converts to an underground cable with surge impedance of 30 ohms, traveling waves are reflected from the junction as shown in the diagrams of Figure 3. The calculations included on the drawing indicate that 89 per cent of the voltage of the traveling wave is reflected while 11 per cent enters the cable.

A corresponding study of the surge impedances existing within the underground cable system must also be made. When a traveling wave impinges on the terminus of an open circuited line, as would be the case in the normally open switch of the loop system, total reflection of the surge occurs with the same polarity, thus doubling the instantaneous voltage at the point of reflection as shown in the diagrams of Figure 4. In the case of radial systems the point of reflection is the farthest transformer in the circuit and almost total reflection occurs because of the high ratio of transformer surge impedance to cable impedance. Components closest to the reflection points are most endangered by the doubled voltage wave, since the effects are modified by attenuation and superimposition of the reflected peak on the forward wave tail as the wave travels back along the cable.

FIGURE 1

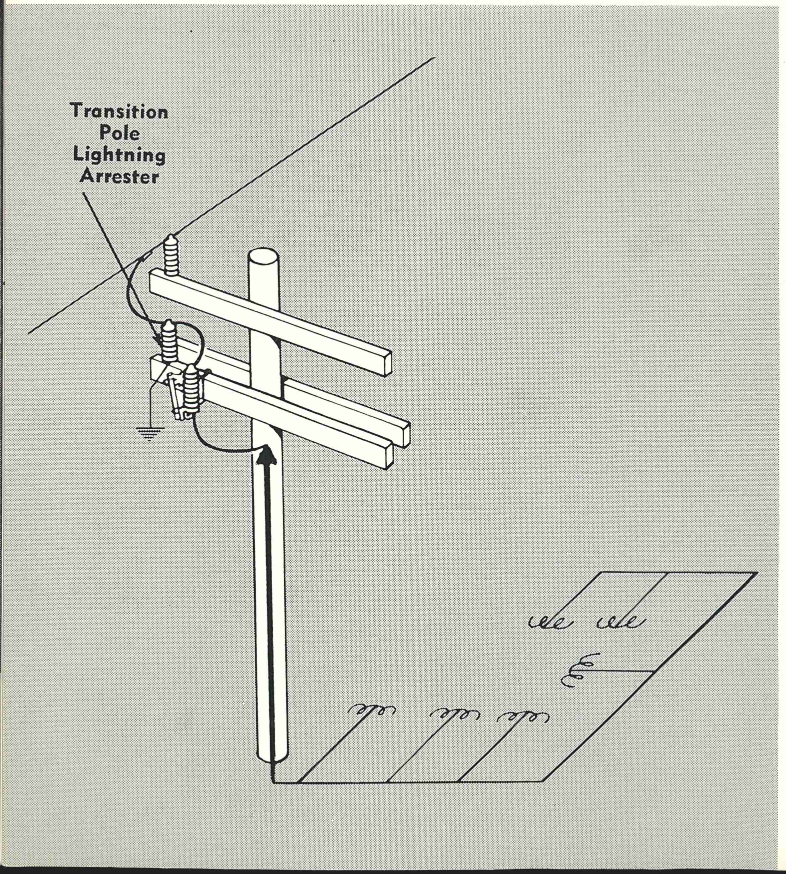



FIGURE 2

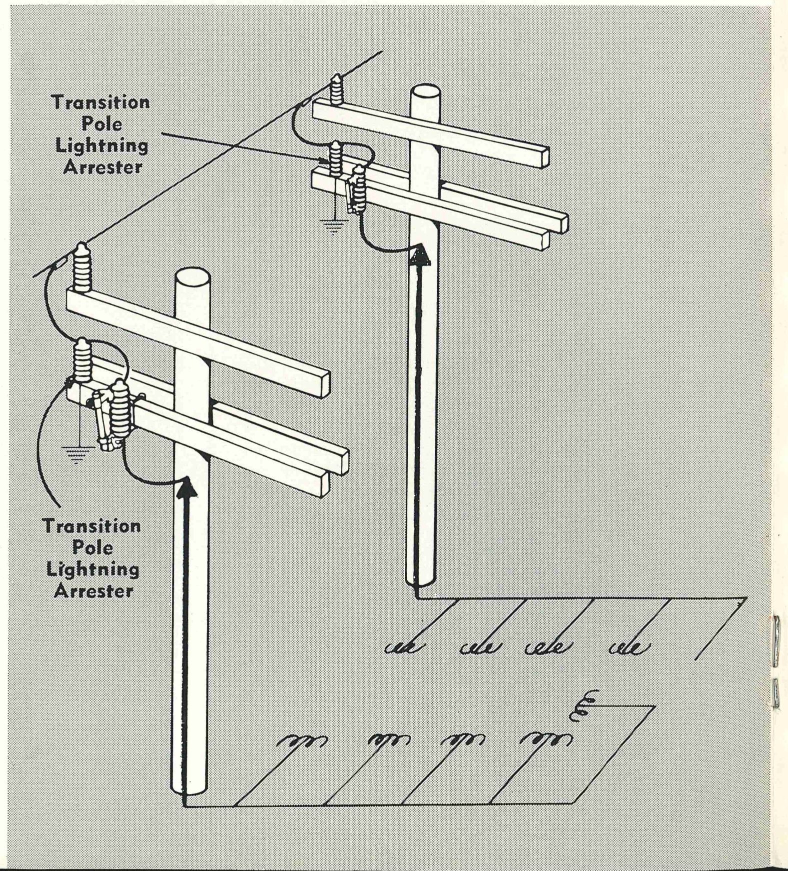



FIGURE 3

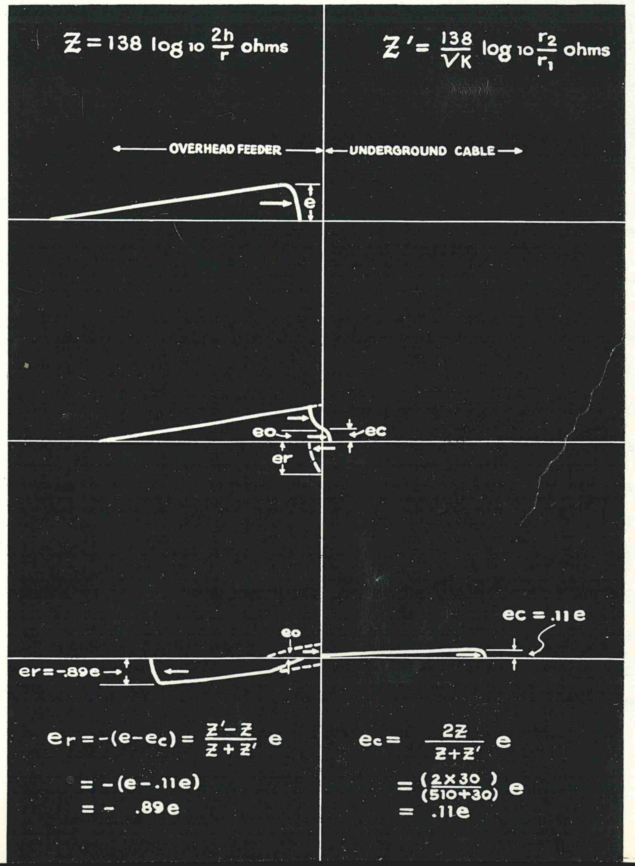



**FIGURE 1** — Radial circuit underground distribution system is supplied by overhead feeder with lightning arrester and fused switch located on transition pole.

**FIGURE 2** — Loop circuit underground distribution system is supplied from two sources on overhead feeder. Two transition poles are required, each with entrance arrester and fused switch.

**FIGURE 3** — Diagrams of traveling wave reflection at junction of overhead feeder with underground cable.

Surge impedance conditions within the underground cable installation must be coordinated with insulation values of the cable and the components, and then related to the protective operation of the transition pole lightning arrester. To reduce outage risks to a level below that of conventional overhead construction, it seems reasonable that the range of overvoltage surge conditions for which protective action is provided should be broadened. Until field experience can be established to indicate the optimum approach to improving reliability, simply extending the protective function of the arresters to safely discharge the 10,000 to 20,000 ampere currents associated with approximately one per cent of lightning strokes provides a tangible direction toward broadening protection.

FIGURE 4

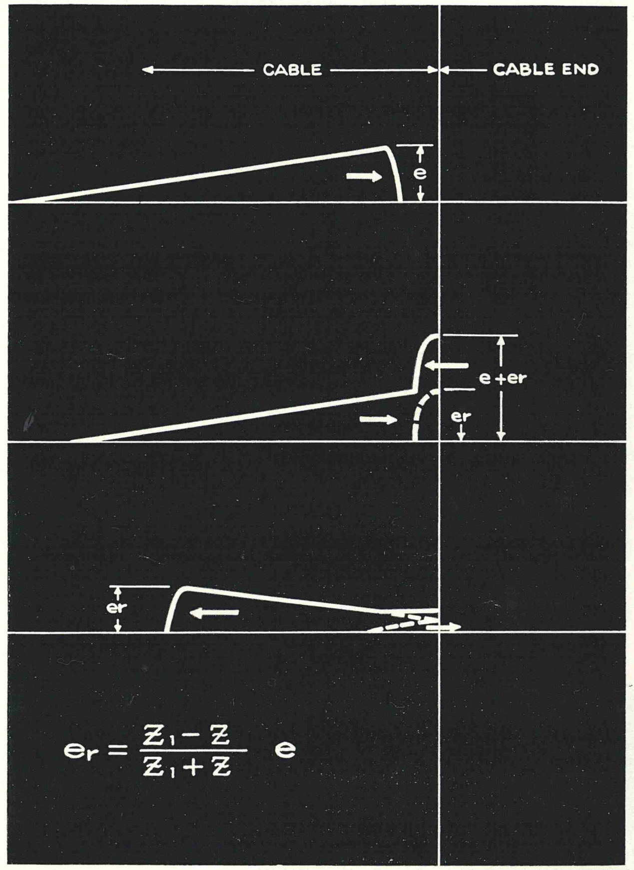



**FIGURE 4** — Diagrams of traveling wave reflection at open end of underground cable.

**FIGURE 5** — Comparison of sparkover voltages and IR discharge voltages for representative O-B distribution, intermediate and station class lightning arresters.

| Arrester Type | Arrester Class | USAS Max Sparkover | IR Discharge Voltage | | |
|---|---|---|---|---|---|
| | | | 3000 AMP | 10,000 AMP | 20,000 AMP |
| DA9 | Dist | 43 kv | 27 kv | 34 kv | 38 kv |
| GP9 | Inter | 31 kv | 19 kv | 23 kv | 27 kv |
| MP9 | Sta | 28 kv | 16 kv | 20 kv | 23 kv |
| DA20 | Dist | 57 kv | 64 kv | 79 kv | 84 kv |
| GP21 | Inter | 68 kv | 44 kv | 55 kv | 63 kv |
| MP21 | Sta | 63 kv | 38 kv | 47 kv | 54 kv |
| DA30 | Dist | 84 kv | 92 kv | 113 kv | 126 kv |
| GP30 | Inter | 97 kv | 63 kv | 78 kv | 91 kv |
| MP30 | Sta | 92 kv | 54 kv | 67 kv | 77.5 kv |

If the surge voltage on the overhead line does not reach the arrester sparkover voltage, no arrester operation occurs, and the surge, reduced in magnitude by partial reflection, enters the cable circuit. Normally this does not constitute a critical condition since surge voltages below a well-defined arrester sparkover voltage, when reduced at the cable entrance and then doubled at a reflection point in the cable system, are still well below the insulation level of system components with adequately chosen BIL's. The condition, however, does emphasize the importance of selecting arrester equipment which incorporates a gap assembly with adequate internal grading and preionization to stabilize sparkover characteristics over a broad range of overvoltage surge wave fronts.

When the lightning surge voltages are sufficiently high to operate the arrester, the arrester grounds the line through its low internal resistance discharge path and effectively prevents damaging surge voltages from reaching the cable junction.

Concern must be given the IR discharge voltages of the arrester, however, since this voltage may exceed the arrester sparkover voltage when extremely heavy discharge currents (10,000 amperes and above) are associated with lightning overvoltage surges. The IR discharge voltage of an arrester is the voltage which appears at the arrester line terminal, equal to the IR voltage drop associated with the flow of the discharge current through the arrester circuit. Internal impedance of the arrester, the resistance of the ground and ground lead inductance are factors in establishing the IR discharge voltage of the arrester circuit. IR discharge voltages of arresters are catalogued characteristics and vary over a broad range for different classes and different makes of



arresters. IR discharge voltage values, using a standardized current wave, are usually tabulated for representative discharge currents of from 3000 to 20,000 amperes.

Examination of the table in Figure 5 indicates that under the infrequent conditions of heavy discharge currents in the order of 10,000 or 20,000 amperes the IR discharge voltage of the distribution class arrester is substantially greater than the arrester sparkover voltage. Under such conditions, voltages could appear at the cable entrance which, when reflected and doubled in the cable system, would reach or exceed the basic insulation level of various underground components. This danger is further compounded by the ever-present possibility that the original insulation strength of underground components has inadequate safety margins or has deteriorated to some degree as a result of aging or operation at excessive temperatures.

Several logical alternatives exist in relation to the minimal protective aspects of distribution class lightning arresters installed at the transition poles. An incremental reduction in the risk of URD outages by extending the protective capabilities of transition pole lightning arresters can be justifiably considered when associated cost factors are comprehensively compared.

Most appropriate over-all recommendation is that intermediate class lightning arresters be specified for all transition pole installations. Many utility engineers faced with the responsibility of providing adequate protection for underground systems have arrived at the same conclusion, as evidenced by the fact that substantial quantities of O-B's Dynagap GP intermediate class arresters are being shipped to locations throughout the country specifically for such applications.

The Dynagap GP arresters are superior to any other intermediate class arresters in all operating characteristics. They are the only intermediate arrester incorporating the current-limiting gap construction, an O-B design improvement which has provided the superb protective features of the modern station class arresters. In comparison with distribution class arresters or others with simple gap designs, the Dynagap GP utilizes strong internal grading circuits which add desired consistency to its sparkover operation and improve its ability to maintain safe voltage levels. The significantly lower IR discharge voltages of the GP are an advantage at the transition pole, since at all levels of discharge current, the voltages entering the cable are correspondingly reduced and are extremely unlikely to reach dangerous levels. Durability characteristics of the intermediate class arresters, particularly of O-B's Dynagap GP with current-limiting gap construction, are another major advantage in transition pole installations, since ample thermal capacity permits multiple operations with heavy current discharges without affecting the operating characteristics of the arrester.

Further benefits from the installation of intermediate class arresters accrue from the superior contamination resistance which is inherent to the larger porcelains and more effective petticoat structure, aided by internal grading circuits. GP intermediate arresters also incorporate O-B's pressure-sensitive, pressure relief facilities.

Where even greater provisions for arrester protection for underground system components are justified or contemplated, the installation of intermediate class arresters at the transition pole can be supplemented by the installation of distribution class arresters at each of the reflection points within the underground circuit. These additional arresters add the assurance that voltage doubling of traveling waves in the cable will be chopped at the point of inception. This arrangement is more common where distribution class arresters are used at transition poles and provides a degree of additional protection in the event of heavy discharge currents.

Physical location of arresters on totally subsurface systems presents

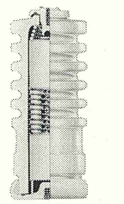


FIGURE 6

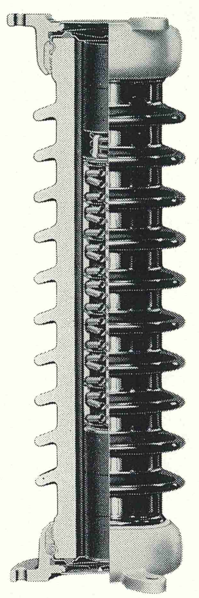


FIGURE 7

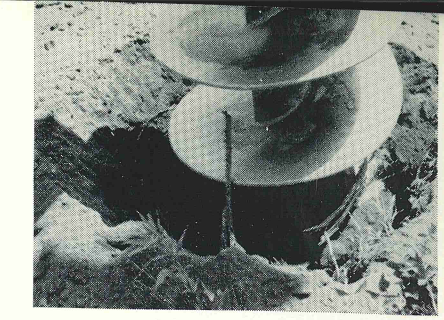
**FIGURE 6** — Section view of distribution class lightning arrester showing how compact construction restricts gap and block size and limits performance in respect to increased requirements of transition pole applications.

**FIGURE 7** — Section view of Dynagap GP intermediate arrester illustrating current-limiting gap with associated grading circuits and heavy duty valve blocks which function together for greatly improved protective characteristics.

a problem which may be solved by the development of a completely submersible arrester or some arrangement by which the arrester can be housed in a submersible assembly. No difficulties, however, are encountered on pad-mounted systems where the installation of arresters corresponds to the normal transformer mounting. Installation of arresters at each transformer is essential on underground systems where unshielded cable is used.

The principal objective in protecting underground distribution systems is to reduce the risk of outages in relation to that considered permissible on overhead feeders. Preferable method is to install O-B's Dynagap GP intermediate class arresters at the transition poles, since the benefits of their over-all superior characteristics provide substantially greater margins of safety and reliability to the entire underground system.

# Here's the business end of Holan's new 5600 earthborer



## Behind it are more power, speed, and economy to put more holes more places fast!

Holes don't come easy. At least they didn't until Holan introduced the new Series 5600 earthborer. It digs a clean hole ready for a pole in a few minutes, spreading the dirt close and evenly around the pole for easy back-filling and tamping. Mounted on a Holan Mustang derrick, it gives construction crews new capability not found before.

Start with what's new in the Holan 5600. It offers controlled two-speed digging with up to a 7,200-pound-foot stall torque output. It "buckles down" to the jobs other diggers stall at — like chewing through rocky and frozen terrain. The new 5600 also offers you a choice of shifting mechanisms for its two-speed operation: remote hydraulic or manual arrangement. And, a compact, rugged, cast steel gear case, cover, and planetary carrier is employed on the new 5600 earthborer to give rugged service.

Performance-proved Holan design criteria incorporated into the new 5600 includes the floating planetary gear train which has proved its dependability and power capability in the field on Holan 5300 and 5400 earthborers. Extra-strength, spur-type gearing in the planetary sets eliminate end thrust. Radial thrust, high-capacity tapered roller bearings assure reliable output-shaft operation.

In normal operation, the 5600's planetary reduction is combined with epicylic reduction for maximum speed reduction when digging. Digging speed is 25 rpm, resulting in 4800 pound feet of torque at 1500 psi when using a suitable SAE power take-off and 7800 pound feet of torque when a split-shaft power take-off drives the pump supplying oil to the drive motor.

To shift into the spin speed of 170 rpm, the output shaft of the driving motor is disengaged and connected directly to the planet cage by actuation of the range clutch. This action bypasses the planetary reduction system, resulting in maximum output speed with a minimum gear reduction between the input and output. Sump-type lubrication of the system provides a simple, fool-proof, and reliable supply of oil to protect all moving parts.

Wide selection of speeds and torque outputs in the 5600 earthborer assures smooth variable speed digging in all environments. The performance curves in Figures 1 and 2 provide a reliable picture of the capability of the new 5600. In addition, the new 5600 earthborer is adaptable and may be easily added to equipment in service or any new unit you may have. Simple assembly and disassembly techniques assure fast and easy service to the complete mechanism.

Now that you know how holes can be dug easier, why not ask your Holan representative to give you a quotation on a new 5600 earthborer. He'll be glad to attach a Mustang 90, 92 or 72 derrick to the input end for an assured reliable source of hydraulic power and an all-around high-performance unit. Or, write direct to: Holan, Division of The Ohio Brass Company, 4100 W. 150th Street, Cleveland, Ohio 44135.

Mounted on a Mustang derrick, the new two-speed 5600 earthborer gives construction crews new versatility — shown here mounted on the Mustang 92-28.

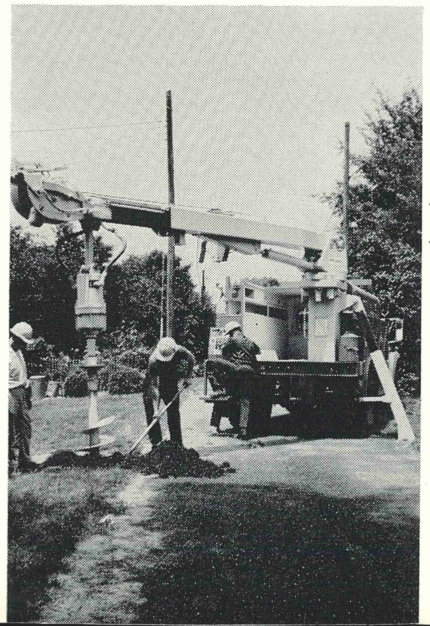


Figure 1 — As auger speed increases the system gallonage input of the 5600 earthborer increases in accordance with this chart.

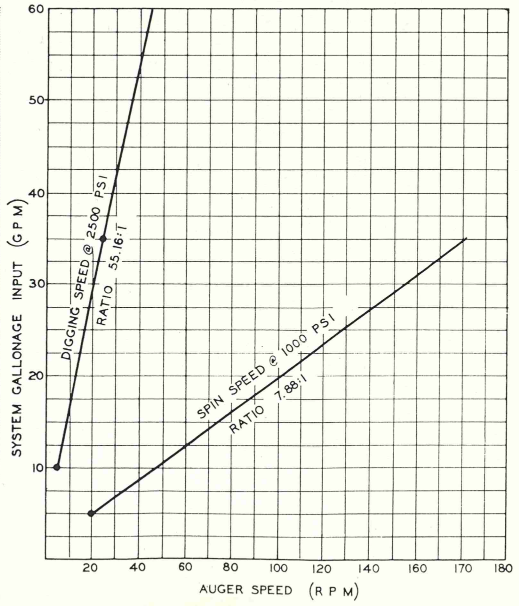
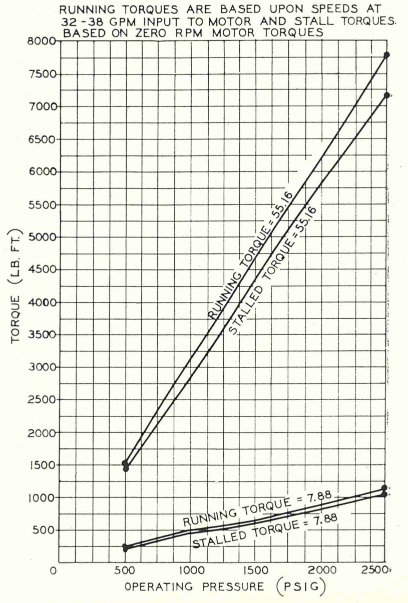



Figure 2 — A comparison of the operating pressures relative to the resultant torque output of the 5600 earthborer reveals its rugged on-the-job capability.



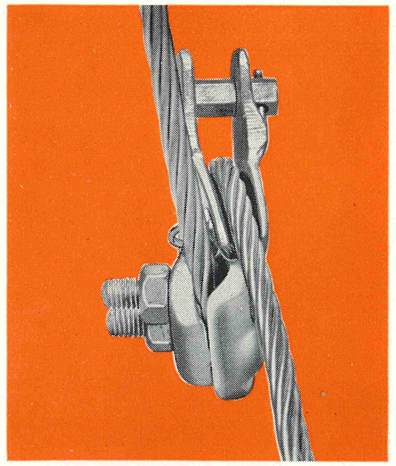

# . . . and you can do it all with JUST TWO HANDS

Directions for installing a deadend clamp: "With one hand, form and hold the conductor into the seat. With the second hand, adjust and position the holding jaws. With the *third* hand, tighten the clamping nuts." The poor human being with only two hands is at a disadvantage, and this includes the majority of linemen.

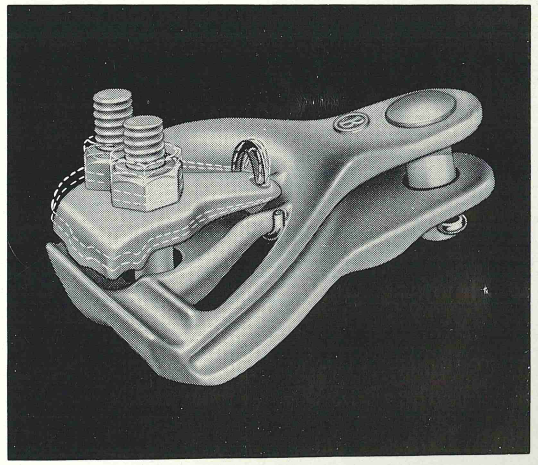
Using the O-B Universal Strain Clamp, Number 88500, is just as good as having a three-handed lineman on the job. Holding jaws are kept in open position and in correct relation to each other by a spring. Open them well beyond the capacity of the clamp and you still don't run out of screw thread and drop a clamping nut. Nothing comes apart. The plain ordinary two-handed lineman can set the clamp easily.

Once installed the Universal Clamp has other virtues. The large circular seat adds snubbing action to the power of the holding jaws and gives the clamp a slipless grip without damage to conductor strands. Where the jumper loop crosses the tensioned conductor, an offset in the clamp body prevents any possible contact that would result in strand chafing. Capacity of this clamp is 0.20 to 0.50 inch. No other clamp we have seen holds a conductor as gently, or as securely, as the Universal.

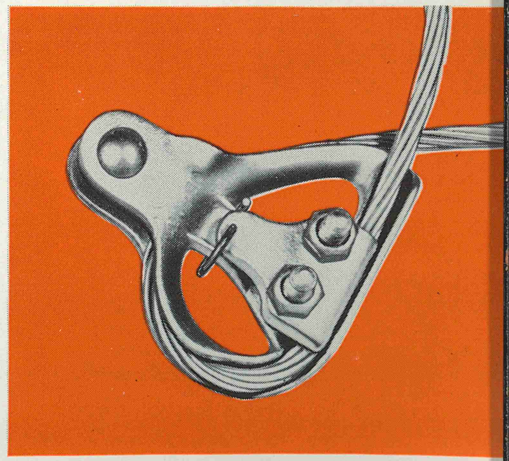
. . . and you can do it all with just two hands!



Positive offset between the jumper loop and tensioned span is permanently maintained in Universal clamp design. The slack loop cannot be forced or vibrated into a position where the conductor will rub and chafe at the point of crossing. This safety feature is established automatically as the holding nuts are tightened. The lineman does not have to tinker with the clamp to get all its advantages.



Holding jaws can open wide enough to accommodate the clamp's maximum conductor capacity, with room to spare, and still not run out of thread on the bolts. Nothing comes apart, and there is no danger of dropping a nut. A spring keeps the jaws open and properly aligned without requiring hand guidance. The O-B Universal Strain Clamp is extremely quick and convenient to install.

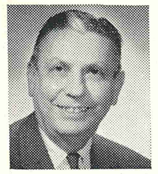


Large circular seat adds snubbing action to the normal grip of the holding jaws. This reinforced holding power imparts high slipless grip on the conductor, along with negligible strand deformation. Universal clamps can be detached and relocated with the former clamped section in the tensioned span. This section will not be noticeable from the ground, and full strength is retained.

OHIO BRASS MANAGEMENT REPORT

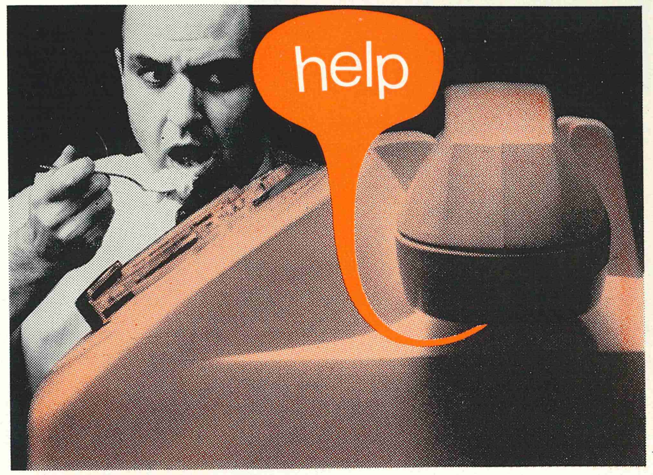
# Can you really do a favor for your customer?

BY ROGER A. BLACK
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY



A few minutes before closing time on a Friday afternoon, the phone rings in the O-B Power Utilities Department. On the line is a district manager. A customer has an emergency requirement for insulators that must leave the factory that night. The order service people go into action. Key people in the factory production organization who have already left for the day are located and called back. Fortunately, the needed products are available, and they are shipped. A few dinners get cold, but the job gets done.

**THE MONDAY MORNING GRAPEVINE** is full of proud comment to the effect that "we really did BCD Power Company a favor." Then some nonconformist slices into our pride: "What do you mean 'favor'? Maybe you've made an extra effort to please a customer, but you think you really did him a favor?" Or consider the extra service that is part of the electric utility's way of life . . . from working 24 hours a day to repair damage done by a tornado or a hurricane to replacing a blown-out fuse for a widow on a sub-zero night. It's natural to think of these deeds as favors you're performing for your customers.




**BUT THEN ASK** the provoking question: "Can we really do a customer a favor?" We can probably develop the idea behind the question quickly from here. When a customer asks us for extra help, he's really doing us the favor, as a follow-up to the original favor of buying our products in the first place.

**THE SAME AS THE ELECTRIC UTILITY,** the bank, or the hot dog stand, we're in business to make a profit. But we can't have profit without the continuing favor of our customers. It's part of being in business, to do everything possible to keep our customers . . . even if factory managers go without dinner, or trouble crews work around-the-clock day after day. So there's the answer: "No, we can't do a customer a favor. He's the one who does the favors. Just make sure we deserve them." 766-H

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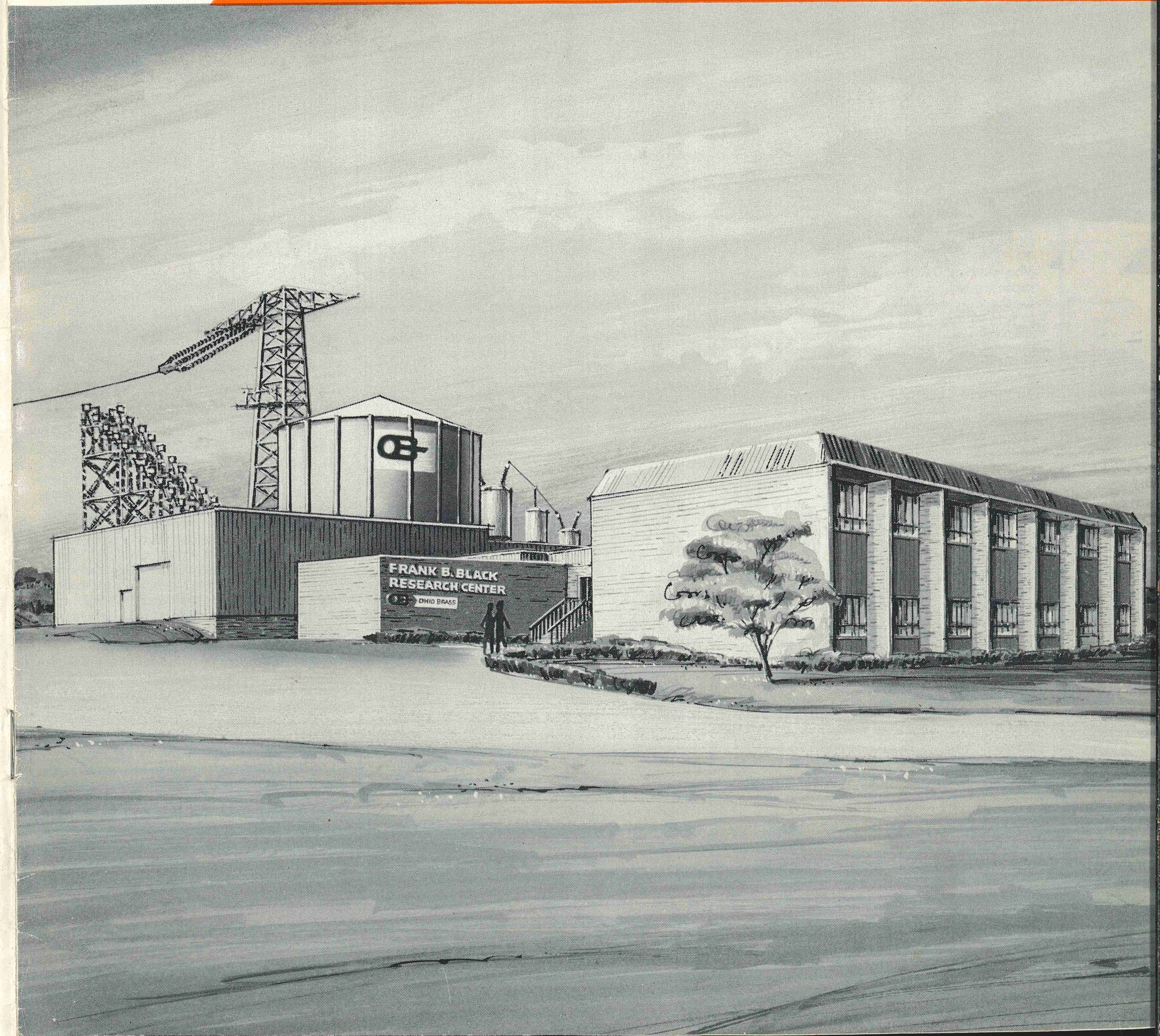
OHIO BRASS

6710-H

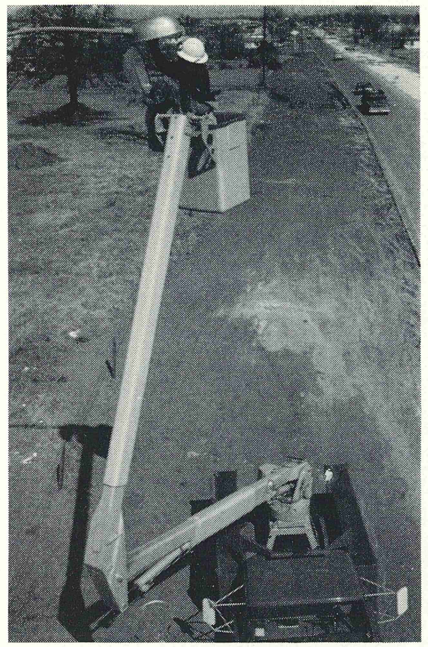
# Hi-Tension News

OCTOBER 1967



# STREETLIGHTS TO EHV . . .

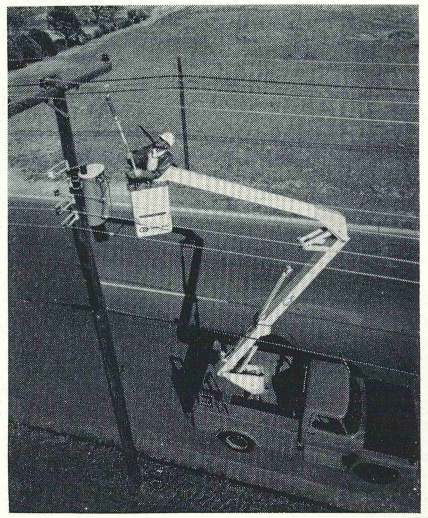
## . . . there's a Bronco to put you on top the job - from Holan



### BRONCO 87

The Bronco 87 is Holan's budget-priced replacement for your limited - access ladder trucks — the Bronco 87 elbow. It's available in two working heights — 32 and 36 feet — and three different models — all-steel arms and bucket; fiberglass upper arm and bucket; and fiberglass upper arm, bucket, and lower-arm insert. Direct cylinder actuation of the upper arm provides a 125-degree upper-arm flight pattern. The lower arm pivots 95 degrees from the horizontal, while the pedestal rotates continuously 360 degrees.

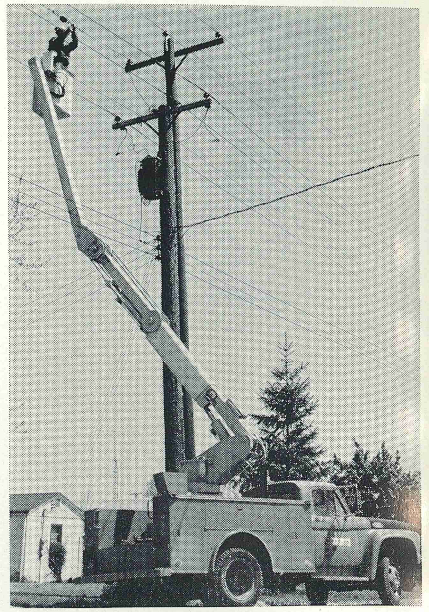
Designed for efficient overhead maintenance on streetlights and low-voltage distribution systems, the Bronco 87 easily lifts a 300-pound payload in men and tools. A rigid base frame and torsion-bar stabilizer eliminate the need for outriggers on the Bronco 87 to reduce set-up time to the minimum. End-of-the-arm bucket mounting assures easy entry and exit to this low-silhouette unit. Standard equipment for the new Bronco 87 also includes a safety selector and override control to override the bucket controls from the lower control station, uniform-stress design of upper and lower arms, and Holan's clear-cut one-year warranty.



### BRONCO 83

For aerial maintenance up to 41-foot heights and one - man troubleshooting crews, take a close look at Holan's compact Bronco 83. Here's an efficient, performance-proved elbow that utility maintenance and construction crews use easily — and often! Three model heights let you choose the working height that's just right for your system — 32, 37, or 41 feet. Fiberglass upper arm and bucket — mounted curbside or street-side on the upper arm — are standard on the Bronco 83 to insure maximum safety when working near energized power lines. Bucket-mounted controls for all elbow movements are also standard.

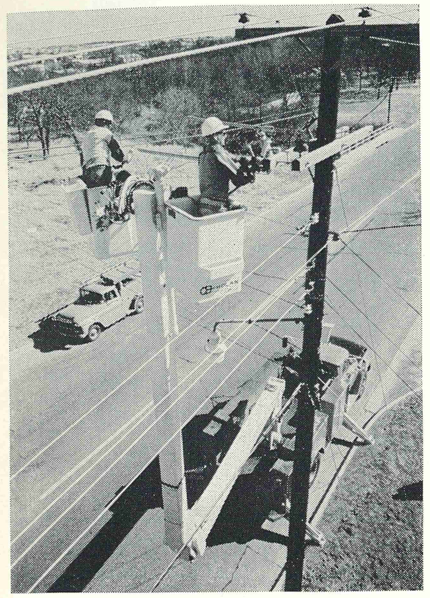
Linkage-type actuation permits the upper arm to move through a 200-degree arc relative to the lower arm which pivots 90 degrees from the horizontal. Continuous 360-degree rotation adds the flexibility to move into nearly any position swiftly and smoothly. A rigid, skin-stressed base frame with integral torsion-bar stabilizer keeps the Bronco 83 steady as a rock — without outrigger jacks — when handling man and tool loads up to 300 pounds throughout its flight pattern. Your Holan representative offers complete application data on the versatile Bronco 83 with just a phone call.



### BRONCO 89

Constant-radius actuation in a light- to medium-duty elbow — that's what's new in the Bronco 89. Designed as sort of a "little brother" to the field-proved Bronco 85 and 88 material-handling elbows, the Bronco 89 offers an upper arm that actuates 215 degrees. This gives your one- and two-man aerial crews the capability to move over center, rotate beneath underbuild, and come up directly to work positions on the field-side of your distribution and subtransmission lines. Available in working heights of 41 and 46 feet, the Bronco 89 offers continuous 360-degree rotation and lower arm that pivots 90 degrees from the horizontal. Constant-radius upper-arm actuation permits addition of Holan's safety-overload device and gives crews the capability to handle material loads up to 1,000 pounds in the upper operating ranges.

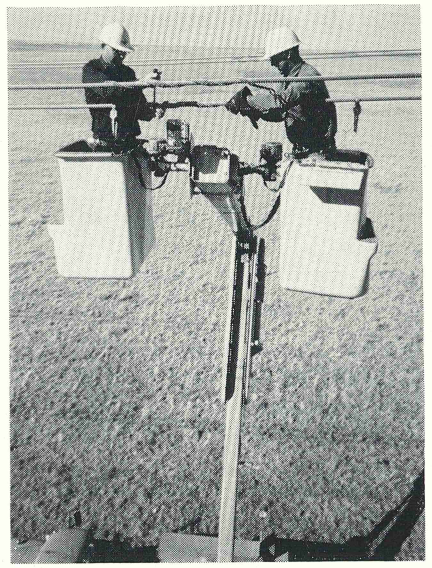
Integral torsion-bar stabilizers furnish rock-solid stability on the 36 - foot bucket-height Bronco 89 without outrigger jacks, while wide-stance jacks are provided on the 41-foot bucket-height version. Both units employ a rugged Z-bar-type base frame. Fiberglass upper arm and bucket are standard on the Bronco 89, with a fiberglass lower-arm insert offered as an option for added insulation strength if desired. Lower central station safety selector and override controls of the bucket-mounted controls are standard on the Bronco 89. It offers either C.O.R.A. or C.B.O.C. mounting, H-frame and bridge. And, Holan provides a full one-year warranty on the new field-proved Bronco 89.



### BRONCO 85

Years of on-the-job performance long ago proved the capability of the Bronco 85 for distribution and transmission line maintenance at heights up to 51 feet. Available in standard and heavy-duty models and working heights up to 46 and 51 feet, the Bronco 85 is a rugged material-handling elbow capable of lifting up to 2650 pounds. Two buckets with swivels may also be included on your Bronco 85 to put two men on top the job anywhere in its flight pattern — 270-degree upper-arm and 100-degree lower-arm actuation.

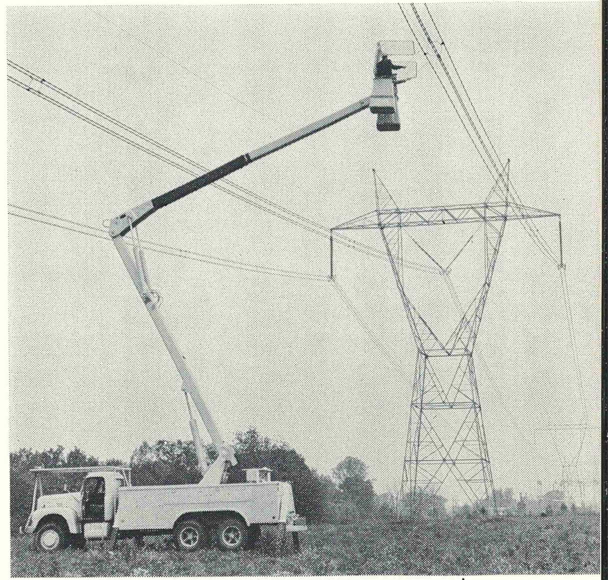
Completely enclosed arm - actuation cylinders make it easy to move in and around power and communication cables without interference and give the Bronco 85 a smooth, safe, modern silhouette. Constant-radius upper-arm actuation assures safe control during material handling and makes possible the addition of Holan's fully hydraulic safety overload device. A rigid, skin-stressed base frame resists twisting and racking, while wide-stance stabilizer jacks insure firm footing during all man and material-handling operations. Holan's shear ball turntable and integral base frame provide smooth, secure 370-degree rotation. And, a fiberglass lower arm is available for the Bronco 85 if additional insulation strength is desired.



### BRONCO 88

Here's the service-proved unit that's capable of handling overhead transmission and distribution maintenance jobs with ease — the Bronco 88. Rated bareshaft lift capacity for the 52-foot working height version of the Bronco 88 is 1600 pounds in any position, while the 57-foot working-height model offers a bareshaft capability of 1450 pounds. Constant-radius upper-arm actuation makes the Bronco 88 elbow an assured safe material handler, and permits 270-degree upper-arm movement relative to the lower-arm. The 110-degree lower-arm actuation and continuous 360-degree rotation system team up with the versatile upper-arm capability to permit crews to maneuver material loads into position on almost any job.

Wide-stance outrigger jacks work integrally with the rigid, skin-stressed base frame in the Bronco 88 to make it one of the industry's safest and most stable aerial units. Holan's fully hydraulic safety-overload device is offered as an option on the Bronco 88 to keep your crews working safely overhead and prevent them from accidentally overloading the equipment. Bucket swivels, a gin pole, transformer-handling device, lower-arm earthborer, remote power pack, lower-arm winch, and other Holan job-oriented options let you tailor a Bronco 88's capability to fit your specific maintenance requirements — including the addition of full Live Line Barehand Method certification for use on 345,000-volt systems.



### BRONCO 29

EHV — that's where Holan's Bronco 29 really proves its worth. It reaches up to 75-foot working heights to put two experienced transmission-line crewmen right up to the suspension point or tower attachment on even a 500,000-volt line — wherever the problem is. Once there, the Bronco 29 will handle up to a 2,000-pound bareshaft load to assure adequate material-handling capability at the work position. The upper arm moves within a 135-degree radius relative to the lower arm which pivots 100 degrees from the horizontal. Continuous 360-degree rotation is standard. Years of field experience have proved its safety and reliability.

Uniform-stress boom design assures even load transfer over the entire arm length. Four wide-stance outrigger jacks in conjunction with the skin-stressed base frame smoothly distribute applied loads and keep this high-reaching unit solid as a rock. Minimum clear insulation for the fiberglass upper arm is 158 inches to insure maximum protection of crews working near energized conductors. A built-in monitoring circuit on Live Line Barehand Method equipped Bronco 29's lets you check leakage current across the unit before each job to insure safe working conditions. And, you have a choice between either a 65- or 75-foot working height with the two models offered in the Bronco 29 series.

Your Holan representative offers more information and quotation data on the Bronco that fits your needs. Ask him which one best fits your crews, or write for additional data to: Holan, Division of The Ohio Brass Company, 4100 W. 150th Street, Cleveland, Ohio 44135



**ON THE COVER:** On a wooded hilltop overlooking the picturesque Chippewa Valley, ten miles south of the Barberton insulator plant, O-B is constructing its new Frank B. Black Research Center, destined to be one of the world's greatest high-voltage laboratories. See page 4.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

# Ohio Brass to build new research center

A new multimillion-dollar research center, including special facilities for conducting research on contamination problems affecting transmission and distribution lines, has been announced by The Ohio Brass Company.

The center will be equipped with electrical, mechanical, ceramic, and chemical test facilities so that research can be conducted on materials and products for all divisions of the company.

Located 10 miles from the Company's Barberton plant, the new facility will be named the "Frank B. Black Research Center," in honor of the former president, board chairman, and pioneer electrical manufacturer who founded Ohio Brass in 1888.

The center will cover 20 acres initially and will include 45,000 square feet of office, laboratory, and indoor test space. The outdoor area for full-scale testing will include a 400-foot conductor span for building prototype transmission line components at voltages up to 1.5-million, both ac and dc.

Completely isolated, physically and organizationally, from daily production problems, the center will be located on a wooded hill overlooking the Chippewa Valley — an ideal environment for creative minds to operate. Completion is scheduled for May 1, 1968.

A unique feature will be a 70-foot-diameter, 60-foot-high, enclosed silo where research on insulation and protective devices can be conducted in an atmosphere completely controlled in terms of moisture, temperature, and contamination. Operating problems encountered by utilities in industrial, coastal, and agricultural areas can be investigated with new precision. The expected result will help overcome the contamination problems which could threaten the reliability of transmission lines being planned for tomorrow's super voltages.

We hope our efforts will be regarded by our utility customers as another demonstration of a domestic supplier's ability to help with the long-range plans of the electric utility industry.

We also have set aside a special section of the center for low-voltage research with the specific purpose of improving both appearance and reliability of distribution lines.

Part of the electrical test equipment will be moved from the present high-voltage laboratory at Barberton. This will include three 750-kv transformers and the 4-million-volt surge generator which will be rebuilt at the new site to increase its capacity to 5-million volts.

# Small plastic insulator handles dozens of distribution construction jobs

It takes just one word to describe the application of O-B's Dirigo plastic insulating unit to distribution . . . CONVENIENCE!

Some pleople raise their eyebrows the first time we mention that O-B makes a plastic insulator. "How long has this been going on?" they ask. Unless the man is past 70, the answer is, "Longer than you've been around."

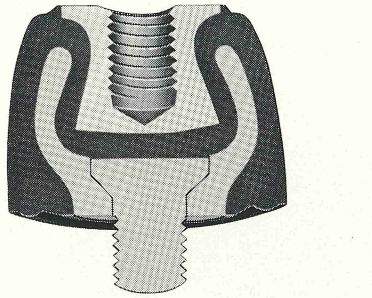
Years before O-B ever made a piece of porcelain we supplied "composition" insulators for electric street railway and mining overhead construction. As knowledge of plastics increased, the formula was periodically improved until, today, we are using what we believe is the best of the modern plastic compounds for this application. O-B is far from being inexperienced in the manufacture of plastics.

Each Dirigo strain insulator, as part of routine production inspection, is tested at 16,000 volts and 5,000 pounds tensile loading. Rated ultimate strength, therefore is 10,000 pounds. The insulator is highly resistant to puncture. For secondaries and service leads it often changes a fussy job into something very simple . . . and very neat. Users report that, taking into consideration the fact that one has a handy pole attachment, a good insulator, and a sturdy clamp, the plastic insulator assembly is often a money saver.

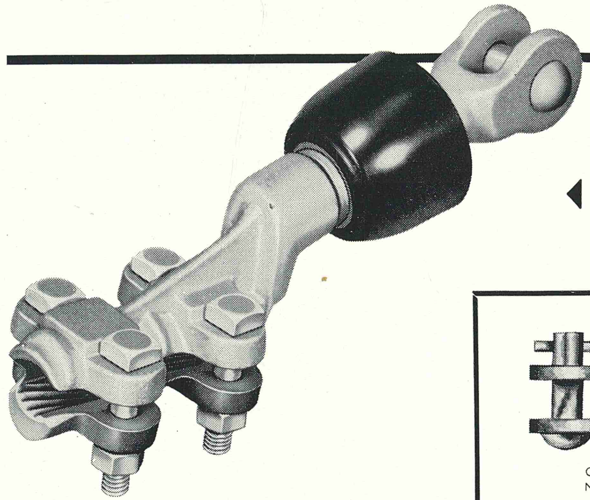
To describe this insulating unit and its accessories we present the accompanying graphic information. It tells more than pages full of words. The basic principle these illustrations depict is broad interchangeability of attachments. The insulating unit contains a threaded connector on one end and a threaded socket on the other, both ⅝-11, USA Standard. Double-ended male threading is accomplished by screwing a stud into the socket connection. Attachments all contain matching threads.

This thread size is commonly encountered in through-bolts and other line hardware, permitting direct attachment to threaded projections without any special mounting provisions.

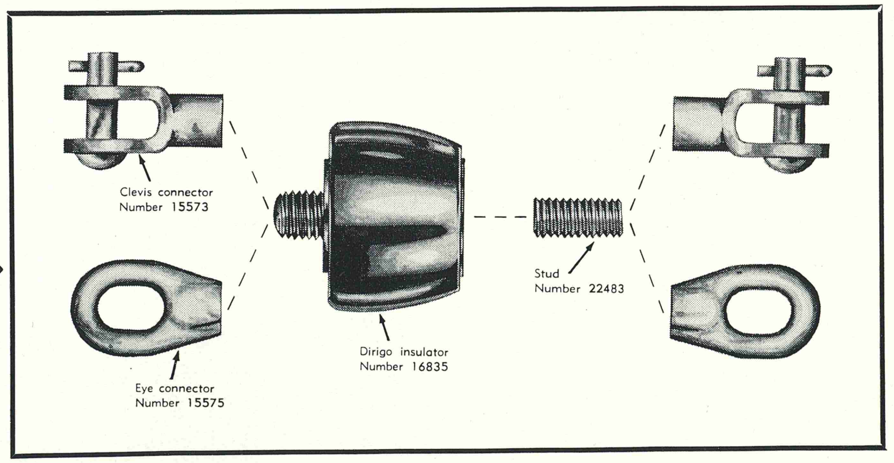
We could go on and on suggesting ways and places to use Dirigo strain insulators and their various accessories, but men who have encountered field problems can probably tell us more than we could tell them. So, look it over and imagine where it would come in handy.



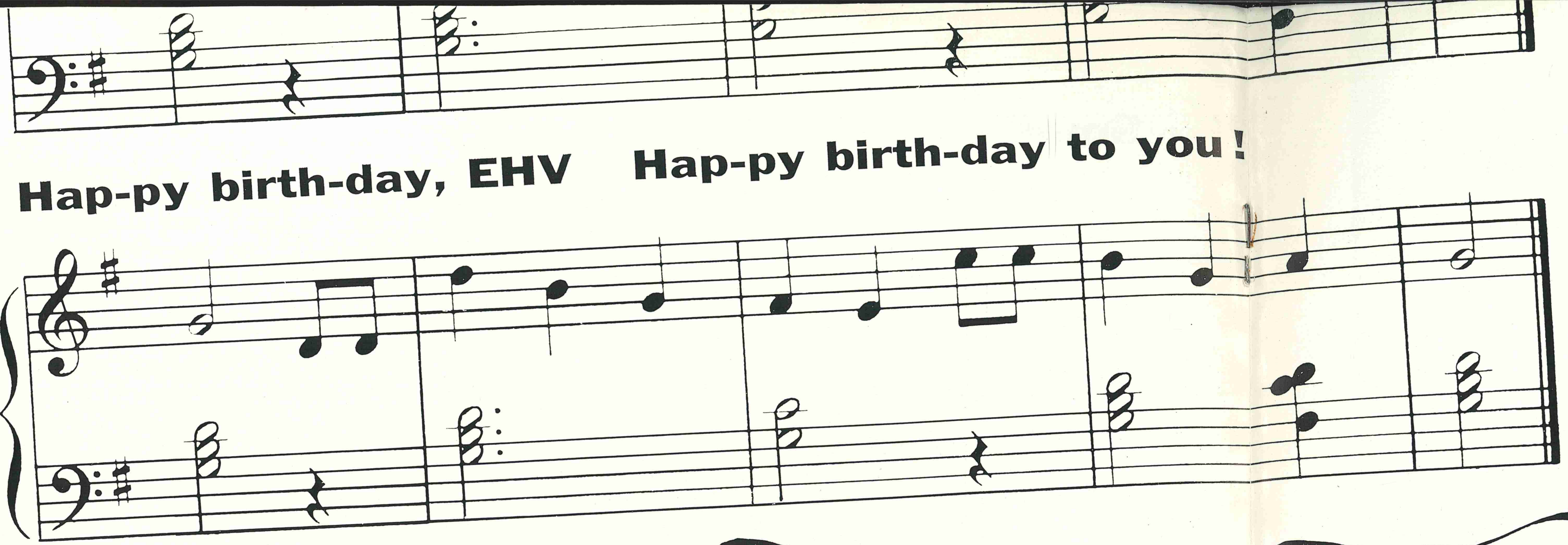
Cross section of a typical Dirigo strain insulator. Dielectric consists of the best available plastic compound which imparts high mechanical and electrical characteristics to the unit.



One of various assemblies with a four-bolt deadend clamp. Lower keeperpiece is bronze in order to interrupt the magnetic loop. Jaws are fluted to engage conductor strands for high holding power. Cable comes out of the clamp at a convenient angle to form jumper loops or make connections. Insulated strain clamp, as shown, is Number 22810 for 1/0 to 500,000 cir mils conductor. The same design, except with a stringing eye, is Number 52536-3001. Similar clamps with clevis or eye connections are also available.




Interchangeable accessories to fit the Dirigo insulating unit. All threads are ⅝-11, USA Standard. The threaded stud which is an integral part of the insulator projects 11/16 inch. Alternate lengths of this stud are 15/16 inch (Number 22483) and 1¼ inch (Number 22836). Strain insulating units are individually tested at 16,000 volts and 5,000 pounds tensile load.



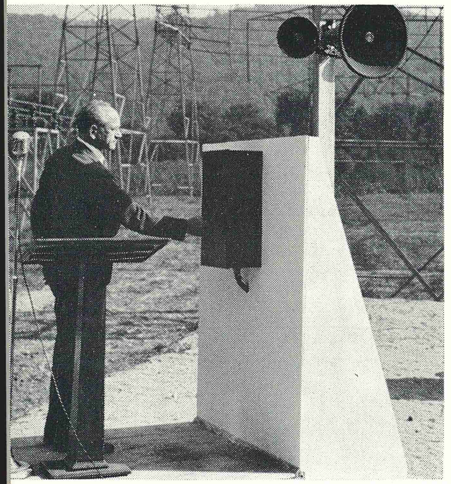

October 1 is the 20th birthday of EHV!

On a clear, crisp October 1, 1947, at the Tidd power station bordering the Ohio River, Philip Sporn, then president of American Gas and Electric Company, threw a switch energizing that company's 500-kv Experimental Project, undoubtedly marking the birth of modern EHV. The ceremony was attended by representatives of electric utilities throughout the country, as well as various manufacturers who co-operated in contributing materials for construction and instrumentation of the switching station and for building the three test lines. Ohio Brass is proud to have participated.

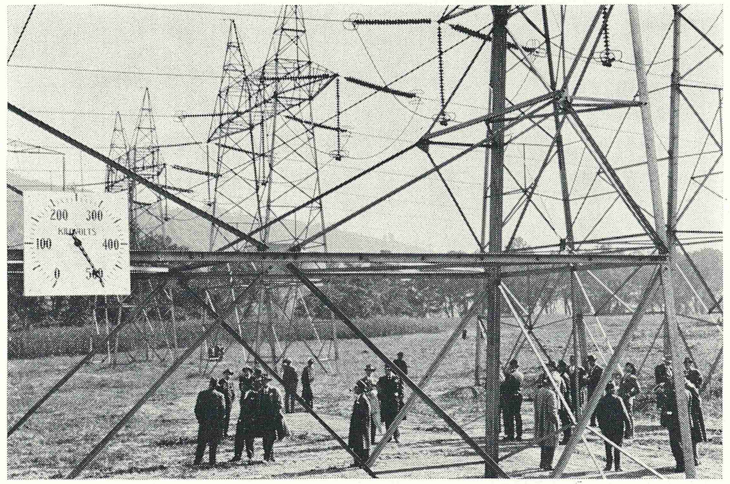
. . . and, as often happens on a birthday, we get out the family album and recall what the little fellow looked like when he arrived on earth. Since "your editor" was one of those present at the dedication, and was carrying his trusty camera, we have sorted through half a hundred pictures in our old files to resurrect a few recollections of that memorable day.

Findings from almost two years of continuous research into extra-high-voltage transmission were then converted into designs. These culminated in the construction of the original 330-kv EHV line between Charleston, West Virginia, and Pomeroy, Ohio, in 1952.

It is significant that the sponsor of the Tidd Project is now building over 1,000 miles of 765-kv transmission.

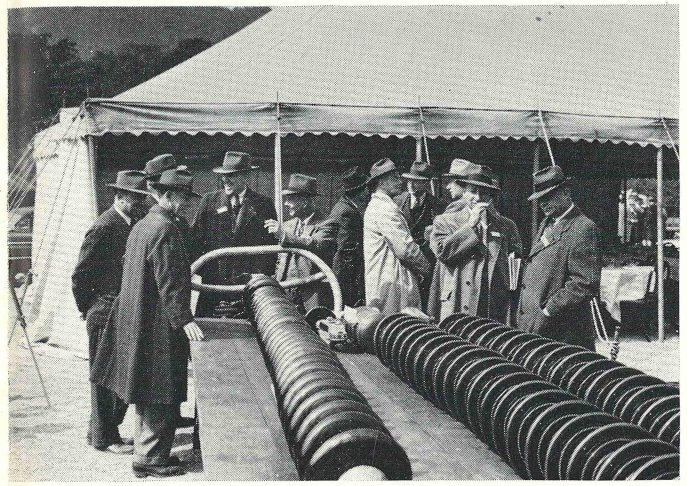


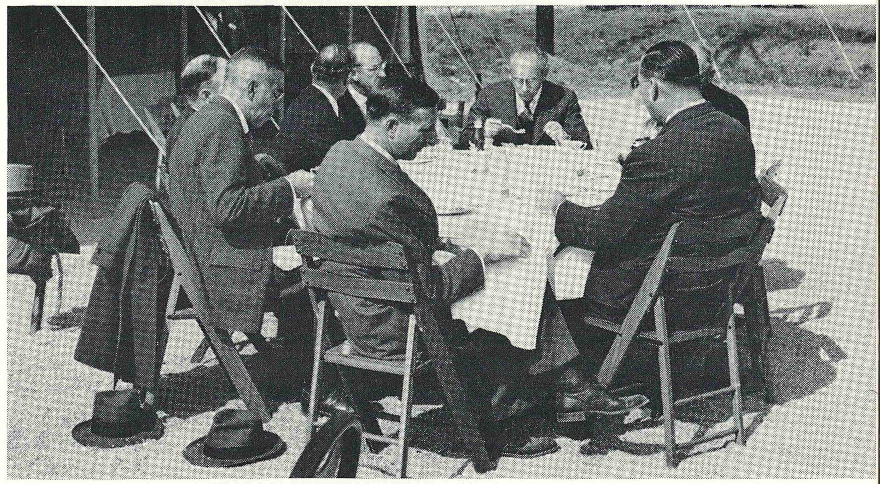
Philip Sporn, then president of American Gas & Electric Company, turns from his dedicatory address, October 1, 1947, to throw the switch officially energizing the 500-kv Tidd Experimental Project.



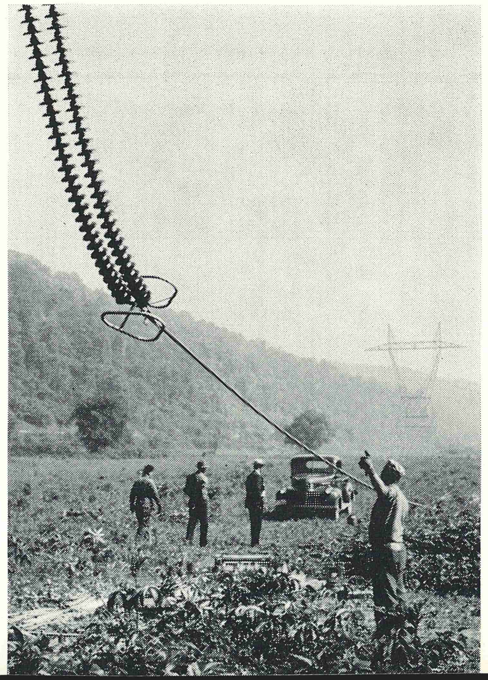

Spectators stroll into the switchyard to experience the noticeable "electrical breeze" created by the overhead conductors carrying 500 kv.

When a dozen insulators was considered a long string, those attending the Tidd dedication were intrigued at the 30-unit strings on display.



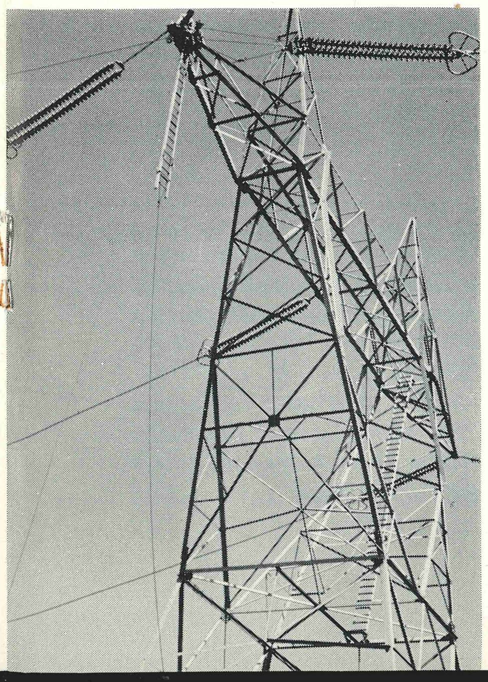


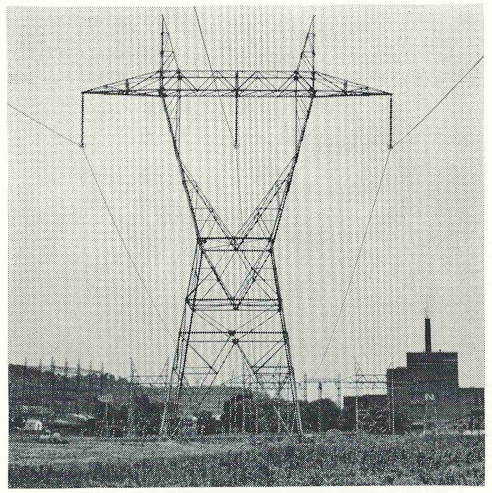
An elaborate luncheon was served, well befitting the importance of the occasion. Perfect Ohio fall weather invited many people to the outdoor tables.



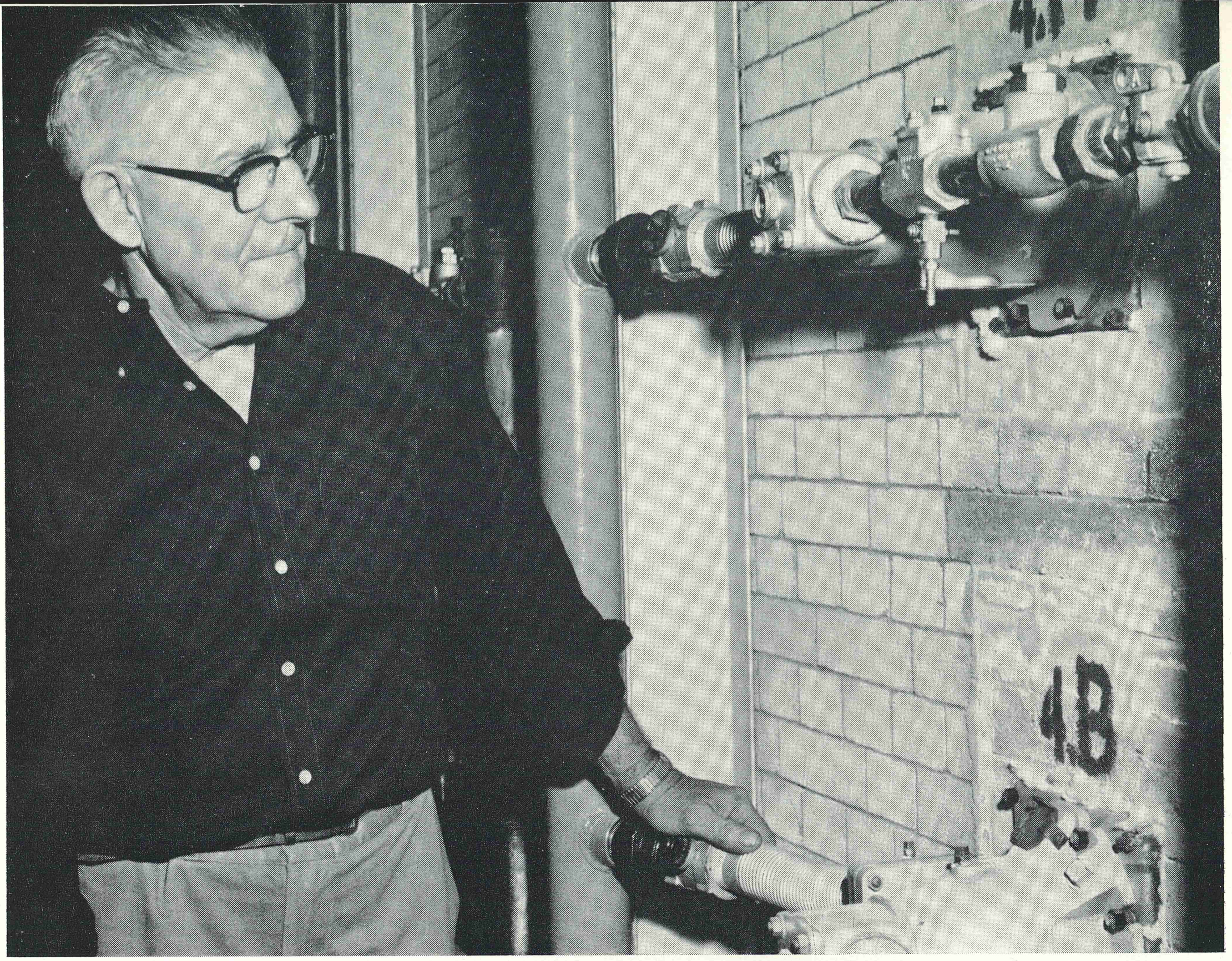
Three experimental lines were constructed, one with a length of 7,290 feet, one 7,180 feet, and a shorter section of 800 feet. This deadend at the end of the long line represents completion of conductor stringing.

A strain tower with double deadends was located in the approximate center of the longer line. It was a new experience for line crews to work with insulator strings of this length and weight.





Tangent tower on the Tidd Project. Somewhat dwarfed in the background is the large station area containing transformers and other equipment, including elaborate test instrumentation. Many meters in the station area, being in a somewhat unhealthy location, were read with a high-power telescope from an elevated instrument house.



# Ray gets his old job back

## . . . and O-B gets 28 years' experience in firing the kiln at our Newell, West Virginia, plant

Among the tangible advantages in O-B's acquisition of its new production facilities at Newell, West Virginia, is its location in the heart of the nation's ceramic manufacturing district. Wherever you turn there is a chinaware plant, a brick plant, or a company making tile.

. . . and this constitutes a very important part of our story of preparing the plant for insulator production in record time.

When we took over the Newell plant we acquired a spacious, clean, well maintained factory. It was originally one of the country's largest producers of chinaware. The buildings were built and laid out for ceramic manufacture. And, above all else, they contained two high capacity tunnel kilns in excellent condition. This meant a year or more saved in getting the plant into insulator production.

First, we installed entirely new burner equipment on the largest kiln . . . far from a minor undertaking. Then came the tedious task of putting the kiln on trial runs to learn its peculiarities. Kilns have as definite personalities as people. You must learn how to live with them. And, like people, you don't do this on first acquaintance.

Now, to get back to the start of our story. Newell is inhabited by skilled ceramic workers. One day, about the time we were ready to fire up the kiln, a man asked to see our factory manager. He wasn't a young man, but was wondering if we had a place for him in our new organization. We inquired about his background. And what do you know . . . 28 years ago he started to work for the Knowles China Company that built the plant. He apprenticed as a kiln fireman, was one of the men who helped build the present tunnel kiln, and fired it from the first day it was ever hot. Literally, he knew it inside and out. He understood it and, secretly, he loved it! Could he run it again, this time for O-B? Our picture shows Ray Crowder, back at his old job.

Things like this have been a big factor in getting Newell onto the line in less than a year after we first saw the plant.



# Significance of IR discharge voltages in evaluating lightning arrester characteristics

Every discussion of lightning arrester characteristics — whether for station, intermediate, or distribution classes — eventually reaches the subject of IR discharge voltages. Comparisons of tabulated values for arresters of different classes and different manufacturers are commonly made as part of arrester evaluations and insulation coordination studies. There is general agreement that low IR discharge voltages are a measure of good arrester performance. While O-B's IR discharge values are the lowest of all manufacturers' cataloged specifications, caution should be noted that IR discharge voltages are just one factor in evaluating the protective features of the modern arrester.

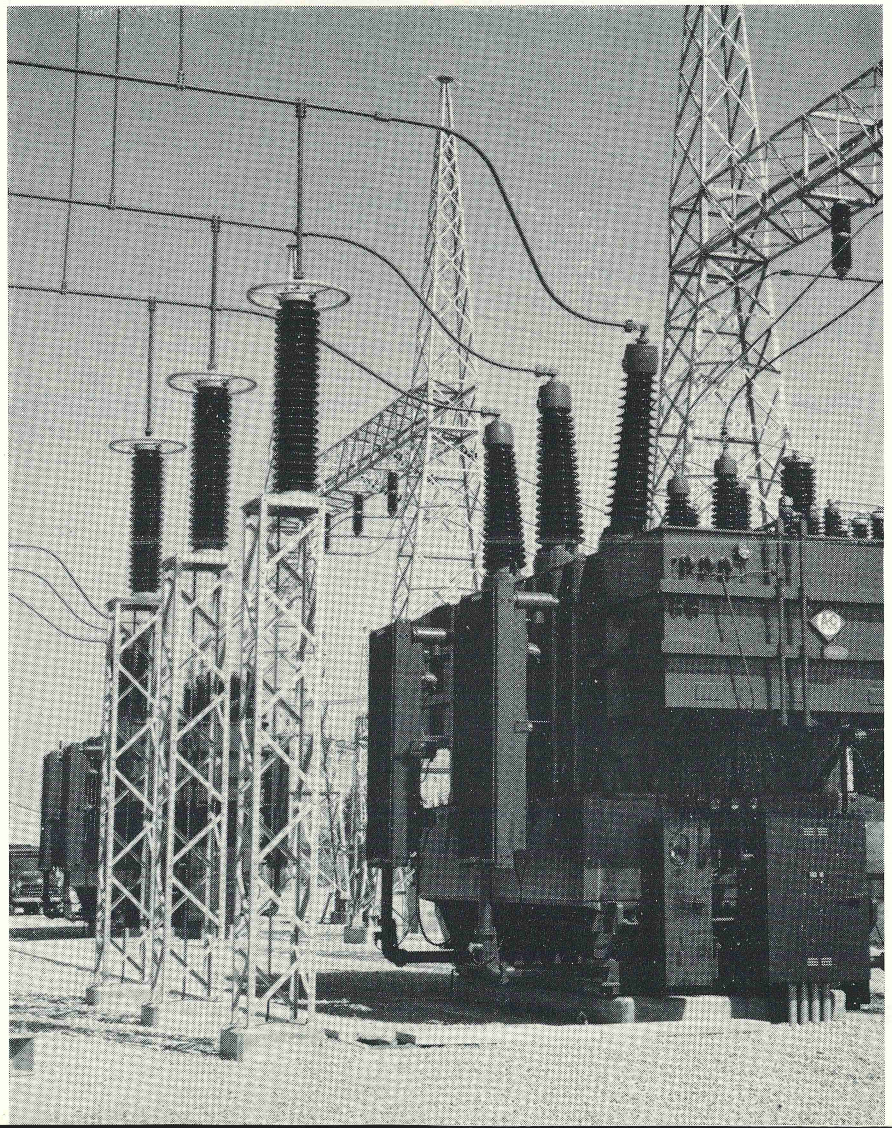
In establishing the significance of IR discharge voltages in respect to arrester performance, a brief review of general operating fundamentals is a helpful beginning. Valve-type lightning arresters are a basic series circuit combination of a spark gap assembly with a nonlinear resistance element. Spark gaps may be of simple gap design or of the sophisticated group known as current-limiting gaps, an O-B development. The non-linear resistance element is voltage sensitive, which means that its resistance decreases in an exponential proportion to voltage increases impressed across its terminals. It is normally referred to as the valve element, thus giving its name to the design classification for this type of arrester.

When the valve-type arrester is connected to the line in conventional manner with its line terminal at line voltage and its opposite terminal grounded, and normal voltage conditions prevail, the spark-gap assembly constitutes a resistance measured in terms of megohms, while the valve element resistance is no more than a few thousand ohms. Voltage distribution within the arrester is, therefore, disproportionately divided between the series elements with the predominant portion across the inactive gap assembly and a very minor portion across the valve element.

When the standby equilibrium of the arrester is upset by an overvoltage surge of sufficient magnitude to bridge the arrester gap assembly, the resistances of the series elements radically reorient themselves. Ionization and sparkover of the air gaps reduce the high initial resistance of the spark-gap assembly to a practically negligible value, which instantly subjects the valve element to the entire voltage potential of the surge. In accordance with its non-linear resistance characteristic, the valve element reacts to the high voltage by a substantial decrease in its resistance, thereby completing the low resistance path to ground by which the surge can be dissipated.

*(Continued on next page)*

Figure 1 — When an arrester discharges a surge current to ground, the IR discharge voltage generated in the arrester is impressed on the terminal of the transformer bushing.



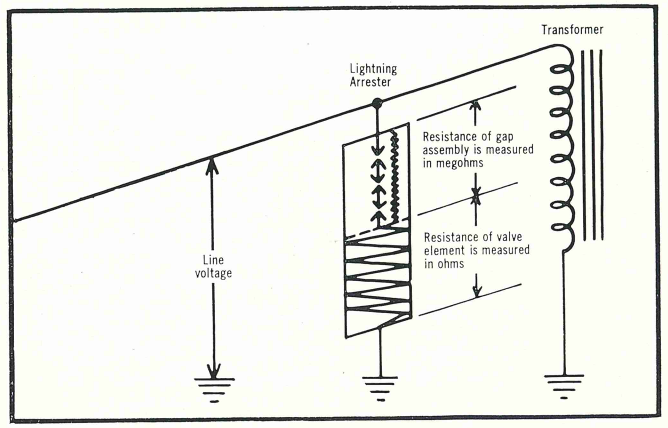



Figure 2 — Diagram showing internal resistance of arrester components under line voltage conditions.

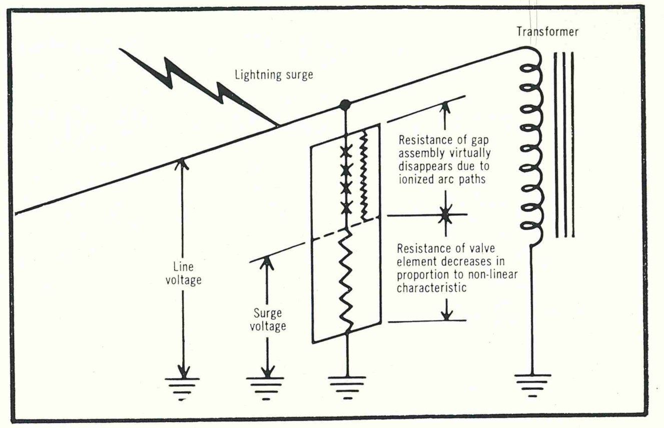



Figure 3 — Diagram showing internal resistance of arrester components when sparkover occurs.

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The instant action of the arrester in providing a low resistance path to ground discharges the overvoltage surge, and the voltage impressed on the arrester returns to its normal level. The spark-gap arc, however, continues to maintain its ionized path, but with the disappearance of the surge voltage, the valve element immediately reverts to a high resistance. This constitutes the first step in arrester interruption of power-follow current, since the increase in valve element resistance restricts the flow of current to the degree that the gap assembly can function to extinguish the follow current arc at or before the next system voltage zero.

Introduction of current-limiting gaps alters the fundamental concept of interruption by the simple gap and valve. The current-limiting gap has provision for generating arc voltage within the gap structure which combines with valve resistance to obtain earlier interruption of power-follow current independently of system-voltage conditions.

The IR discharge voltage of an arrester is defined as the voltage which appears across the terminals of the arrester during the time an overvoltage surge discharges through the arrester. It is called the IR discharge voltage, since it equals the voltage drop which occurs between the arrester terminal and ground when the current associated with the overvoltage surge discharges through the series-resistance circuit which comprises the arrester path to ground.

The dual requirement made on arrester valve elements involves low resistance values while conducting surge current and high resistance values while conducting power-follow current. Only a non-linear resistance material can accomplish both of these objectives. Silicon-carbide crystals, with their binding material, have been found to possess this desirable non-linear resistance characteristic and can be formed into an excellent voltage-sensitive valve element. Specific properties of silicon-carbide resistors can be advantageously altered by variations in composition and forming, and intensive laboratory research has shown excellent results in achieving combinations with greater suitability to lightning arrester applications. Modern valve element technology is, for example, responsible for stabilizing characteristics to the degree that heat generated by heavy or multiple discharges does not change its resistance values.

The importance of matching valve characteristics to the spark-gap assembly of the arrester is reflected by both the interruptive capabilities of the arrester and the magnitude of the IR discharge voltages which result during the discharge of surge currents. The ideal would be a non-linear valve element with infinite resistance at line voltage and infinite conductivity at surge voltages. This Utopia would reduce IR discharge voltages to nearly zero. Under present conditions valve elements are of the lowest impedance consistent with the duty required for the gap-interrupting operation. Valve properties can be shifted with greater latitude in combinations with O-B's current-limiting gap where more and more of the responsibility for power-follow current limitation is being transferred to the gap assembly. Lower impedance and greater durability of valve blocks are obtained in such applications.

The least defined variables inherent to the consideration of IR discharge voltages are in connection with the surge current associated with the overvoltage which actuates the arrester. The overvoltage surge may be caused by lightning, which is normally characterized by an extremely steep front surge of short duration, or it may have as its origin a switching operation which produces a surge with a slow rising front and a comparatively long duration.

Principal aspect to be considered in connection with the surge current is its magnitude. Many studies have been conducted on the phenomena of lightning and all conclusions point to their completely unpredictable nature. Generalized observations indicate that the current component



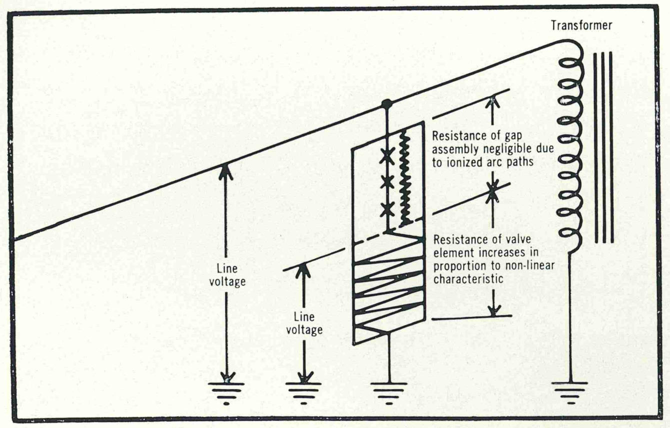



Figure 4 — Diagram showing internal resistance of arrester components after surge discharge.

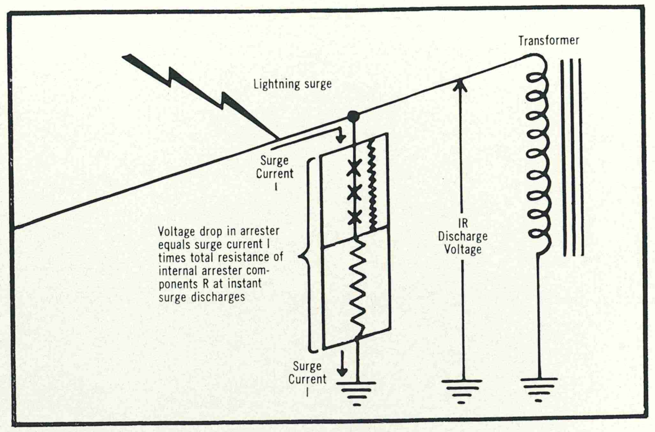



Figure 5 — Internal resistance of arrester generates discharge voltage when surge current is diverted to ground.

can vary from less than 100 amperes to as much as 100,000 amperes, with evidence that the extremes in this range are very rare. Perhaps the most appropriate guide to estimating lightning currents is the data in IEEE paper 51-190 by E. Beck, where the probabilities for arresters connected to unshielded lines are tabulated as follows:

| | | |
|---|---|---|
| **Once In One Year** 100 amp | **Once In 3½ Years** 1500 amp | **Once In 13 Years** 5000 amp |
| **Once In 45 Years** 10,000 amp | **Once In 200 Years** 20,000 amp | |

This particular tabulation has the advantage of being easily coordinated with the cataloged values of IR discharge voltages for specific arresters, since laboratory tests must necessarily be based on arbitrarily chosen values of discharge current.

Current components of surges discharged through the arrester can be presumed to have wave-front variations resembling those of the surge voltages and therefore, can range from the steeply rising lightning types to the slowly rising fronts of switching surges.

The total IR discharge voltage generated, then, is dependent upon two factors: (1) the rate of the surge current increase and (2) the surge current magnitude. As a result of these two effects, the crest IR discharge voltage that appears between the arrester terminals is not necessarily coincident in time with the crest current. Duration of the IR discharge voltage is also determined by the wave shape of the surge-current discharge, a factor which requires specific consideration in relation to high-voltage switching-surge sparkovers.

An 8 x 20 microsecond current wave has been adopted by the industry to determine representative values of IR discharge voltages for the various surge currents and specific arresters. This choice of surge-current shape gives correlative IR values to the 1.2 x 50 microsecond-voltage wave used in insulation strength ratings.

In summary, all valve-type arresters require inherent resistance in their discharge paths in order to provide current limitation and allow power-follow current interruption. IR discharge voltages are produced when the current generated by the overvoltage surge passes through the arrester's series circuit to ground. Cataloged IR discharge voltages use a standard 8 x 20 microsecond surge-current wave of various representative magnitudes.

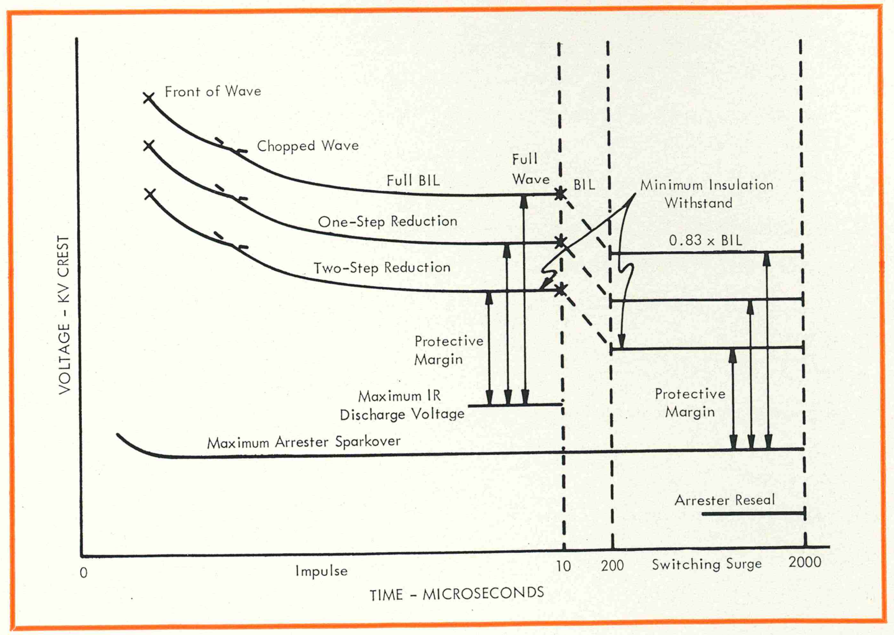
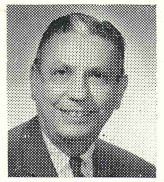



Figure 6 — The IR discharge voltage of an arrester determines the protective margin for impulse voltages as shown in the insulation coordination diagram.

OHIO BRASS MANAGEMENT REPORT

# We invest in ideas for the electric utility industry

BY ROGER A. BLACK
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY



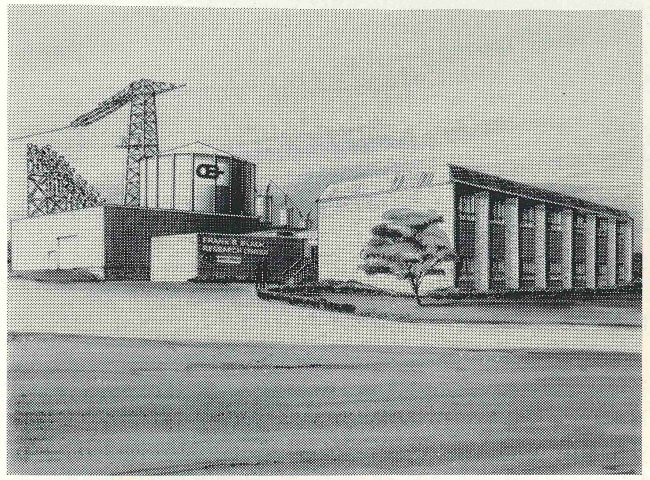
A few miles from our Barberton, Ohio, plant, bulldozers are clearing ground for the new Frank B. Black Research Center—the third major laboratory to be built by Ohio Brass. To answer your questions about the name, "Frank B. Black" was my father who founded the company in 1888.

**AMONG MANY RESEARCH TOOLS** in the new center will be generators for testing transmission line components, a c and d c, over 1.5-million volts; a 5-million-volt impulse generator; and a special silo for working on contamination problems in a controlled atmosphere.

**YOU MIGHT ASK WHY** a company the size of Ohio Brass would spend several million dollars on a research center. Why not leave the glory of research (and the expense) to the giants of the industry, or to the government? Since we asked ourselves some of the same questions, you might be interested in our answers.

**FIRST, THERE ARE REAL NEEDS** to be filled. Lightning was once the big threat to transmission line reliability. Five years ago switching surges took over. As we move to the 1-million-volt level, contamination seems to be the biggest threat. Since there is no U. S. facility for precise investigation of contamination problems, we're building one. We also see other unfilled needs in electrical distribution . . . for increased reliability and beautility.

**SECOND, RESEARCH TO FILL** well-defined needs is a prime way for a domestic supplier to demonstrate its advantages over an offshore source . . . providing a service of ideas as well as products. **Third,** 60 years




ago O-B decided to serve the electric industry rather than the automotive business. We still like our choice. The new center provides tangible evidence of a continued desire to serve an industry which has been good to this company.

**FOURTH, TO CONTINUE OUR LEADERSHIP** as a supplier of insulation and protective devices for EHV, we have to assume the responsibilities and risks that go with leadership, and that includes investing in research. A leader has to lead. So we look at this considerable investment as a logical step in our service to the electric utility industry, as a way to continue to make meaningful contributions to its progress.

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OHIO BRASS

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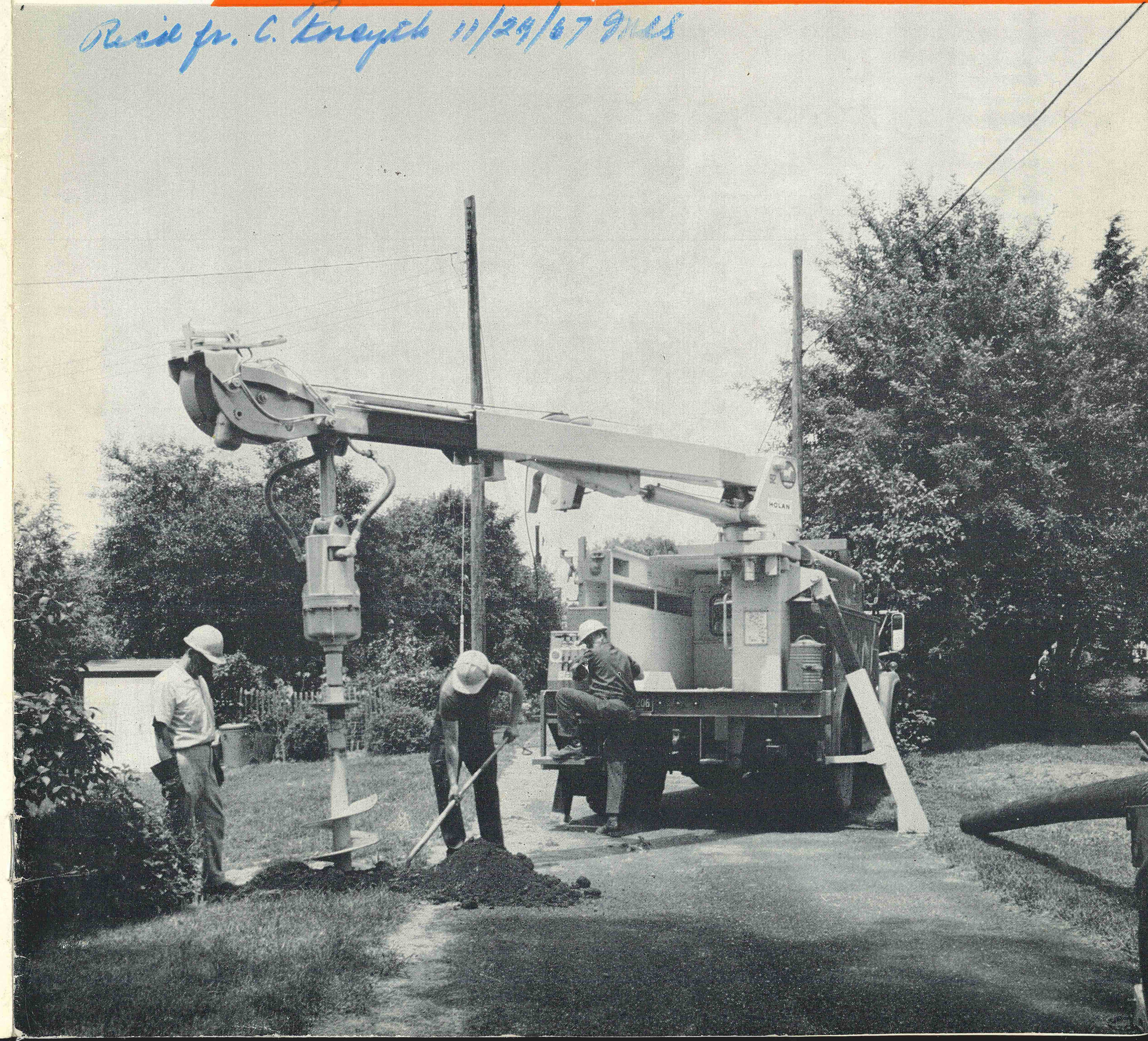
# Hi-Tension News

NOVEMBER 1967



# IT'S YOUR CHOICE... with mobile derricks from Holan

Here are five Holan derricks to dig holes, set poles, and handle material on distribution to transmission systems

## MODEL 3750 'A' FRAME

Years of rugged field experience long ago proved the durability and strength of Holan's Model 3750 A-frame derrick. Its design is simple to insure reliability, yet it's strong enough to handle up to a 75-foot pole or 12,000-pound material load with ease. Equipment as heavy as 5,000 pounds may be positioned well forward of the rear axle on the 3750's body platform to permit the unit to load itself and carry the

material to the job as well as install it.

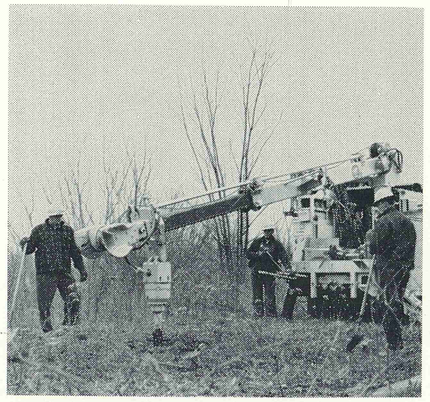
On the job, you just position the Model 3750's carrier vehicle, engage the hydraulic system, lift the A-frame boom out of its saddle, and go to work. From its over-the-cab storage position, the boom pivots 195 degrees to permit placement of the roller-type sheave head within five feet of the ground.

A telescoping integral stiff leg with double-acting hydraulic cylinder gives the Model 3750 plenty of muscle to hoist heavy loads with ease. Locking it into position on the base frame is simplified by an automatic aligning device. Rectangular side legs of the boom are made of long-lasting hi-tensile steel, while a fabricated cross support adds extra rigidity and strength.

For a matching earthborer to fit the Model 3750 derrick, select either the single-speed 5300 new two-speed 5600 or three-speed 5400 with torque outputs up to 9,000 pound feet. Controls for operation of the earthborer and all other derrick functions are located conveniently at the rear corner of the unit.

## MUSTANG 72

Prefer a radial-arm derrick with a lift capacity of 10,000 pounds and the ability to set up to 65-foot Class 1 poles? Mustang 72 is the name to specify for assured in-service reliability on just such jobs. And, there are two models to select from — 26- or 32-foot sheave height — with three different mounting configurations: RHRC, CBOC, or CORA.



MUSTANG 72

Mounting of the 365-degree rotation system within the base frame of the Mustang 72 results in a low center of gravity for mobile stability on and off the highway. Wide-stance outrigger jacks furnish rock-solid stability on the job. Uniform-stress design of the boom assures even load distribution, even when lifting the Mustang 72's maximum load capacity of 10,000 pounds.

To match a Mustang 72 for your service needs, add several of Holan's job-oriented options. Select either the single-speed 5300 or two-speed 5600 earthborer with torque outputs up to 7,000 pound feet to dig clean holes fast. Then, add a cable compensator to take up to one-inch synthetic rope, a six or eight-foot pin-on boom for extra reach, a bucket with remote controls to put a man on top the job, or Holan's automatic hydraulic safety-overload device for maximum operating safety. Ask your Holan representative for performance history and application information on the Mustang 72 in your service area.

## MUSTANG 75

Here's Holan's original cornermount derrick — the Mustang 75. Since its introduction in 1959, hundreds of Mustang 75's have gone into service all over the world. Today, they're still giving the rugged dependable service for which they were designed.

MUSTANG 75

Available in sheave heights of 26 and 32 feet, the Mustang 75 offers a 195-degree working radius off the rear of the unit. It easily digs a hole and sets a pole from curbside without special positioning or tying up traffic. Maximum bareshaft lift capacity for the Mustang 75 units are 13,100 and 11,100 pounds for the 26- and 32- foot models respectively.

From its storage position over the cab, the Mustang 75's boom pivots over 200 degrees to touch the ground. Teamed with Holan's heavy-duty 5400 earthborer, the Mustang 75 offers a maximum down-feed pressure of 5400 pounds and digging torque capability of 9,000 pound feet to put holes in the most stubborn terrain. With the hole dug, the Mustang 75 will "live boom" 8500 pounds — more than enough strength to handle up to 70-foot poles.

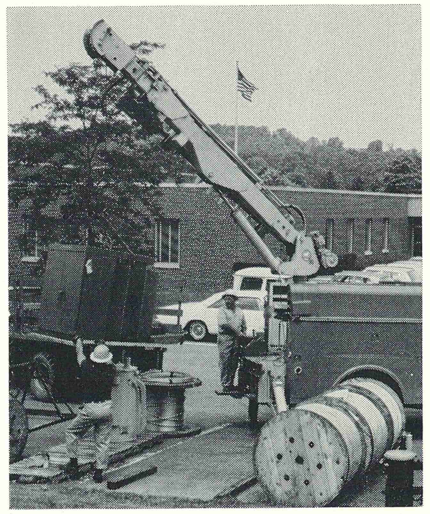
Holan offers numerous options for the Mustang 75, too. Select either a 2½- or 5-foot extension boom, a 10,000-pound winch, fiberglass extension boom, bucket with remote controls, or other work-oriented equipment to match the needs of your maintenance crews. Your Holan representative will be glad to furnish additional information with just a call.

## MUSTANG 90

In the Mustang 90, Holan offers the industry's strongest mobile derrick to handle your present heavy-duty jobs and the increasing demands of the future as poles get bigger and hardware heavier. The 29-foot sheave-height unit offers a lift capacity of up to 19,000 pounds, while the 34-foot sheave-height model will handle 14,500 pounds at maximum boom angle. Side pull capacities range up to 1000 pounds — ample evidence of the built-in brawn in the Mustang 90.

Uniform-stress boom design in the Mustang 90 provides maximum lift capability with a minimum of weight, and assures even load distribution when handling material loads. Mounting of the 360-degree rotation system down inside the base frame resulted in a low center of gravity in this heavy-duty unit to insure on and off the highway stability in transit. Strong, wide-stance outriggers assure solid footing for the Mustang 90 on the job. Movement of the superstructure inside the body side boxes adds even more stability to the Mustang 90.

MUSTANG 90



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Hi-Tension News
Nov. 1967, Vol. 36, No. 11

**ON THE COVER** — Compact Mustang 92 with 5600 earthborer adds a new choice for you in the wide range of field-proved Holan derrick equipment.

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902

*(continued from previous page)*

Available for RHRC, and CORA mounting, the Mustang 90 is also offered with a large group of options. For digging torque capability up to 9,000 pounds, the three-speed Series 5400 earthborer makes an ideal companion for the Mustang 90. A cable comensator, manual pull-out boom, fiberglass bucket with remote controls, sheave head with detachable pole flares, and Holan's automatic hydraulic safety overload device are also offered for the Mustang 90. Your Holan representative will be glad to furnish additional information about the Mustang 90's application potential on your system and detail its service history with just a call.

## MUSTANG 92

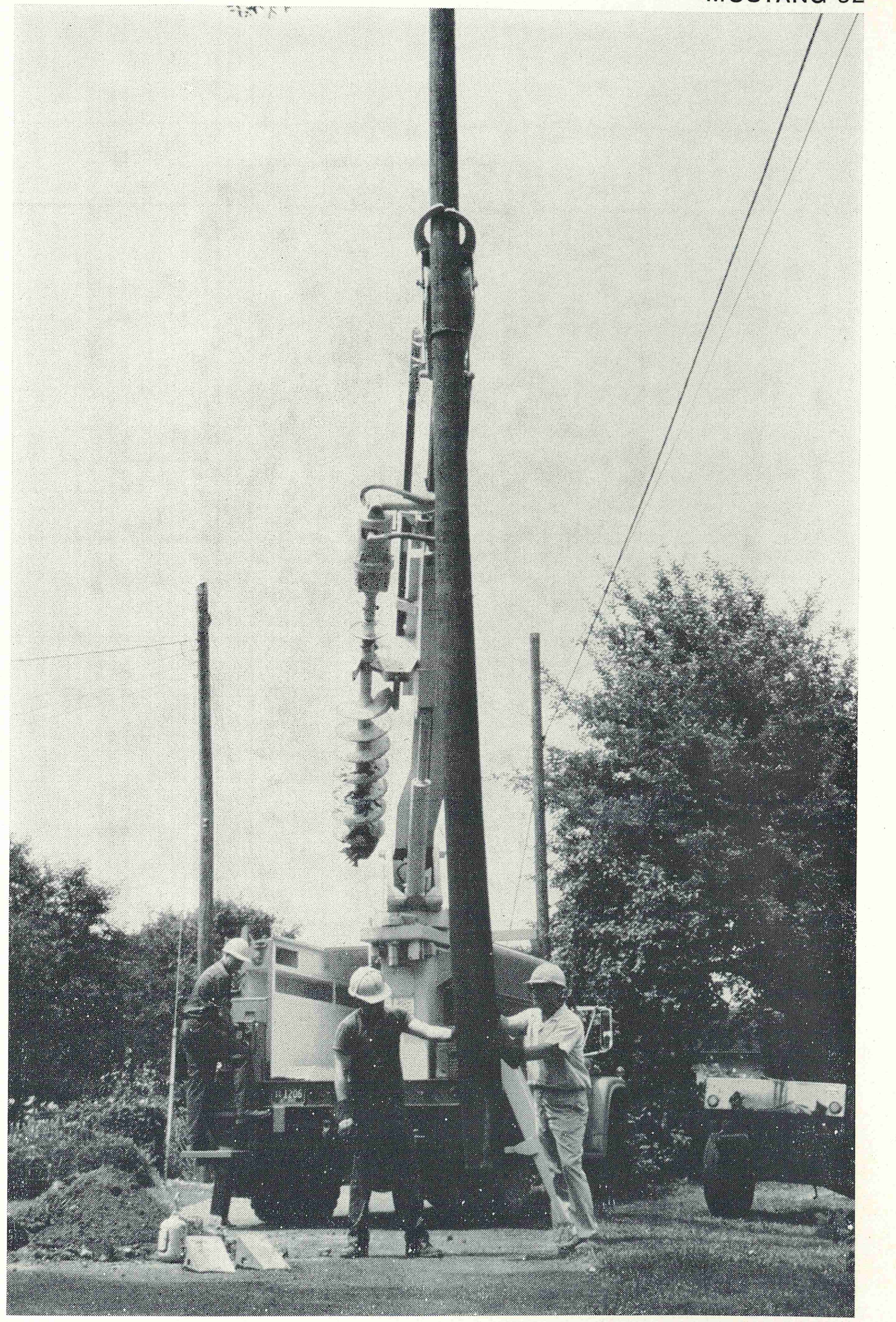
Compact enough to get into almost any work site; strong enough to get the job done once it's there — that's Holan's new Mustang 92. Just introduced this year, the new Mustang 92 already proved its capability to dig holes, set poles, and handle material loads in field experience with utilities across the country. Walk, plumb, and set up to a 60-foot pole, lift up to a 13,500-pound material load, or reach up 28 feet to install a transformer on a pole — they're all jobs made to order for the compact Mustang 92.

Design simplicity was the keynote during development of the Mustang 92. New engineering features introduced with the Mustang 92 include location of the winch under the pedestal, a new fixed-strut with floating block cable compensator design, and a new gear-type rotation system. The result? — The versatile Mustang 92 which offers side-pull capacities of 600 pounds extended, 800 pounds retracted throughout the 360-degree rotation pattern. Mounted RHRC, CORA or CBOC, the Mustang 92 handles a single or two-speed mechanical or hydraulic earthborer with up to a 7,000-pound-foot torque capability. And, wide-stance outrigger jacks furnish sure footing on the job for safe operation in all terrains.

Like all Holan derricks, the Mustang 92 has a complete range of job-oriented options to custom tailor a unit for its applications. Add a mechanical or hydraulic pole claw, a pin-on boom, pedestal-mounted winch, fiberglass bucket with remote controls, or even the hydraulic safety overload device to round out your Mustang 92's field capability.

Ask your Holan representative for complete details on this compact new workhorse.

MUSTANG 92



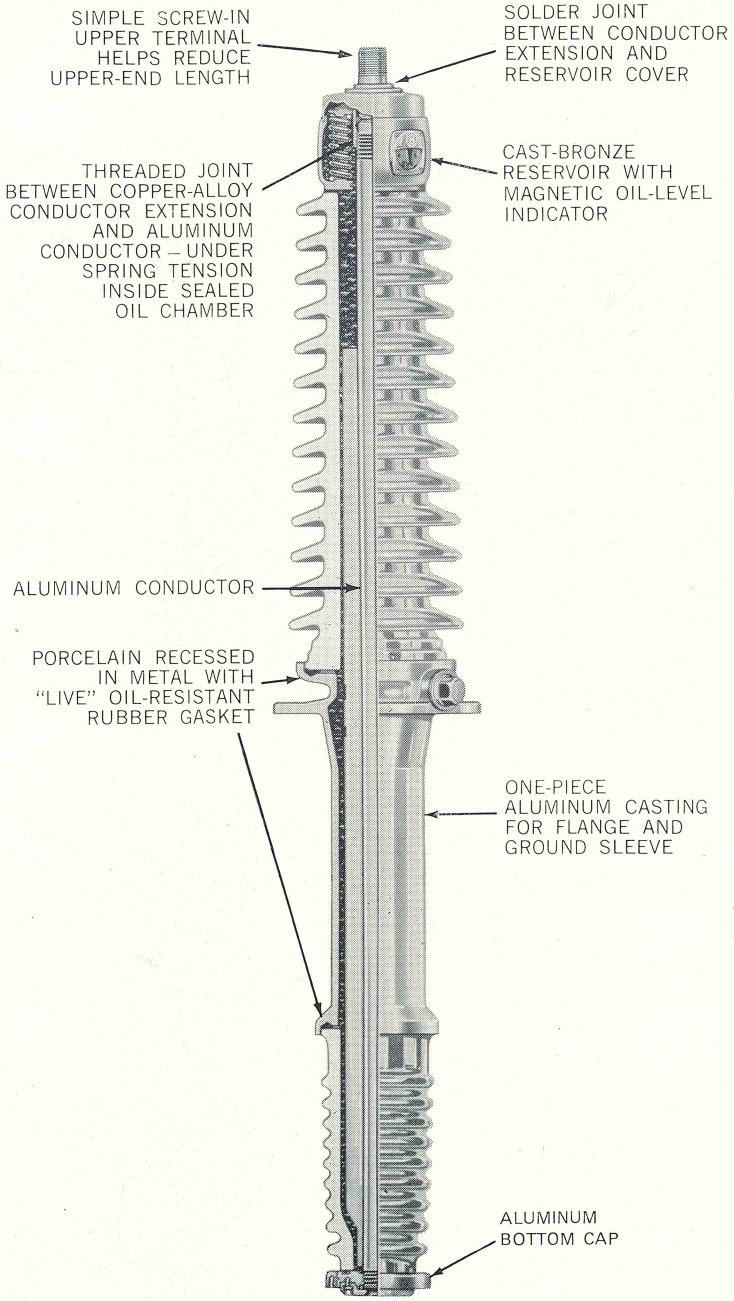


# New design GK-40 Breaker-Tran Bushing now in production

Ohio Brass carries on a continuing development program on capacitance--graded bushings, with emphasis on lighter equipment and improved circuit-breaker performance. Today's circuit-breakers, required to meet progressively higher interrupting ratings, demand bushing designs paralleling these requirements.

Latest product of this development program is O-B's new GK-40, 115-kv insulation-class bushing Number 49400, now in production. Approximately 200 pounds lighter than the previous design, it is a 1600-ampere, fixed-conductor or 800-ampere, draw-lead transformer bushing and is suitable for 2000 amperes in circuit-breaker service. BIL of the new bushing is 550 kv, and it meets present USA Standards in all respects.

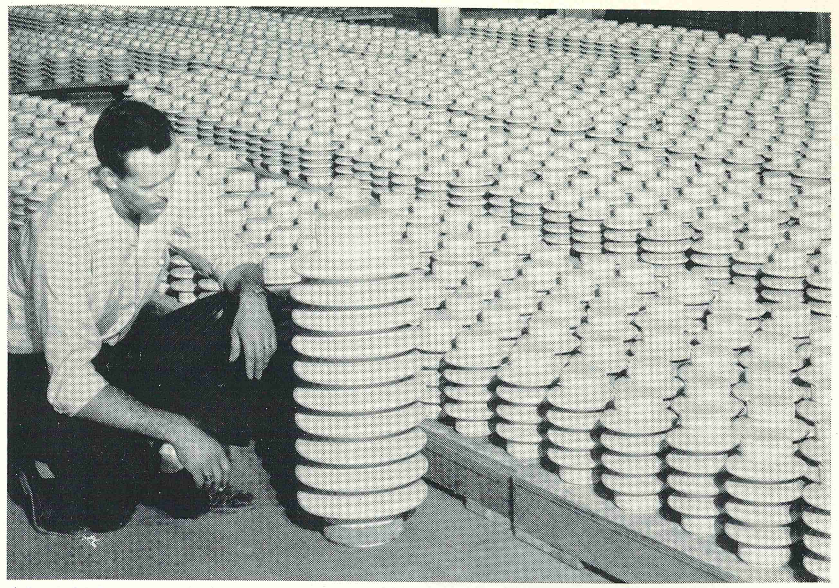
This bushing has several design innovations. The conductor tube is aluminum, as is the lower terminal plate. The upper copper alloy terminal threads directly to the copper alloy conductor extension instead of bolting to the reservoir cover nut as in previous designs. The transition from aluminum to copper alloy is made inside the sealed part of the bushing through a threaded connection which is continuously under the full spring loading. Bushing Number 49400 features a one-piece aluminum casting for the flange and ground sleeve, as in the lower-voltage bushing line.



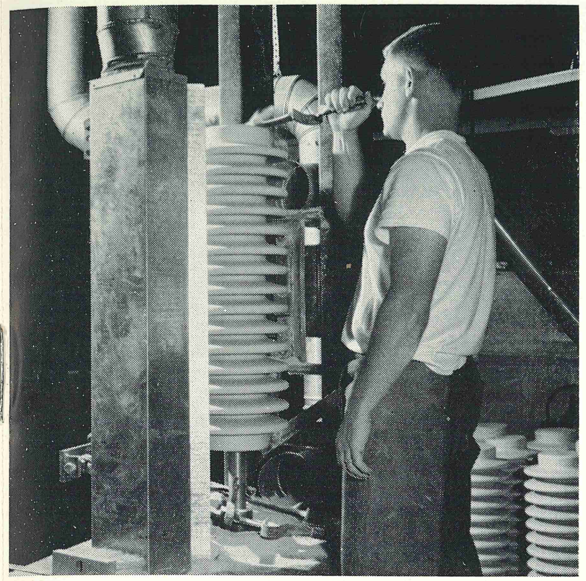
# Post production in full swing at O-B's new Newell Plant

"What kinds of posts do you make at your new Newell, West Virginia, plant?" "Is production, after only a year since the plant was acquired, any more than a token effort?"

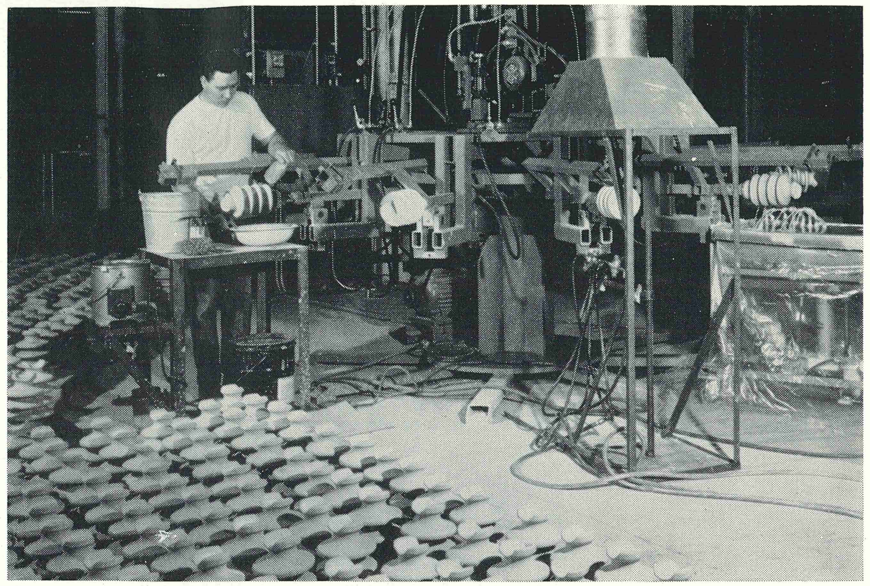
We can tell you that we are running in high gear, but, as the old saying goes, "A picture is worth 10-thousand words." Here are a few close looks at O-B's Newell post production as it is swinging along today.



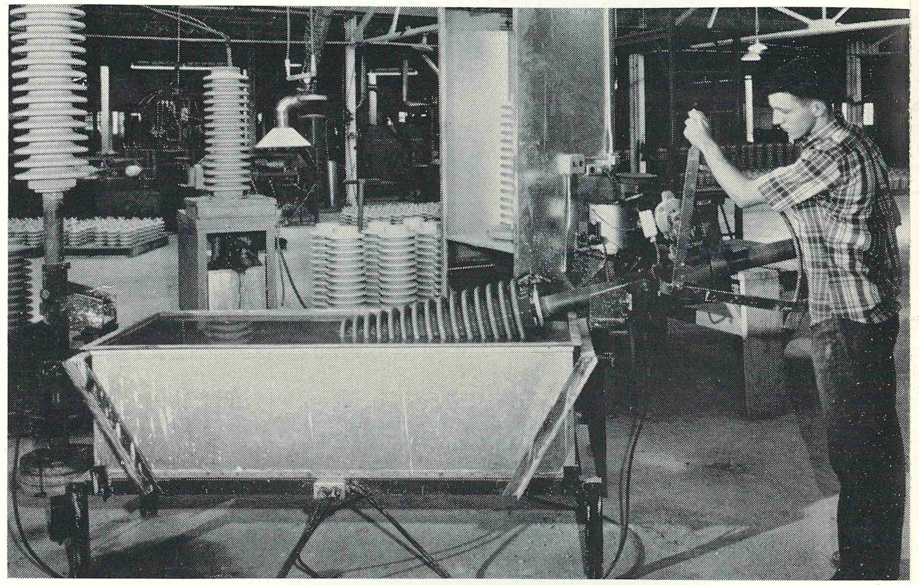
After forming and drying, posts await final trimming and glazing operations.



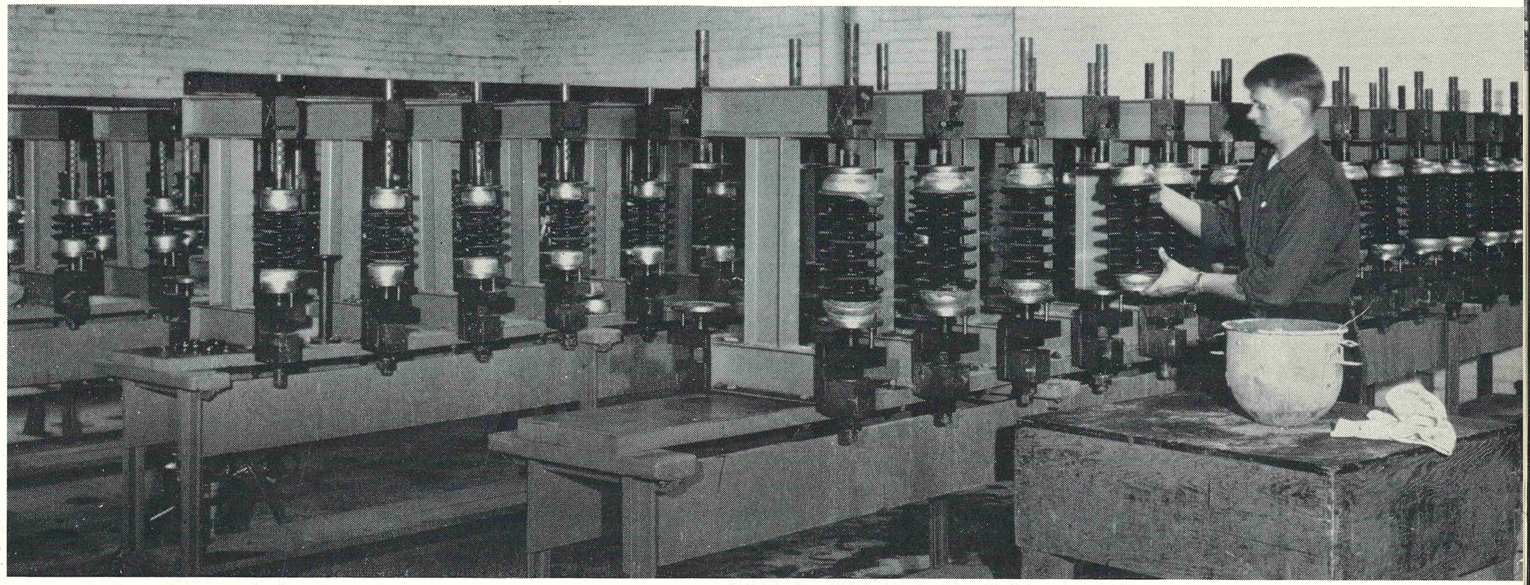
Trimming and finishing the porcelain for large station-post insulators.



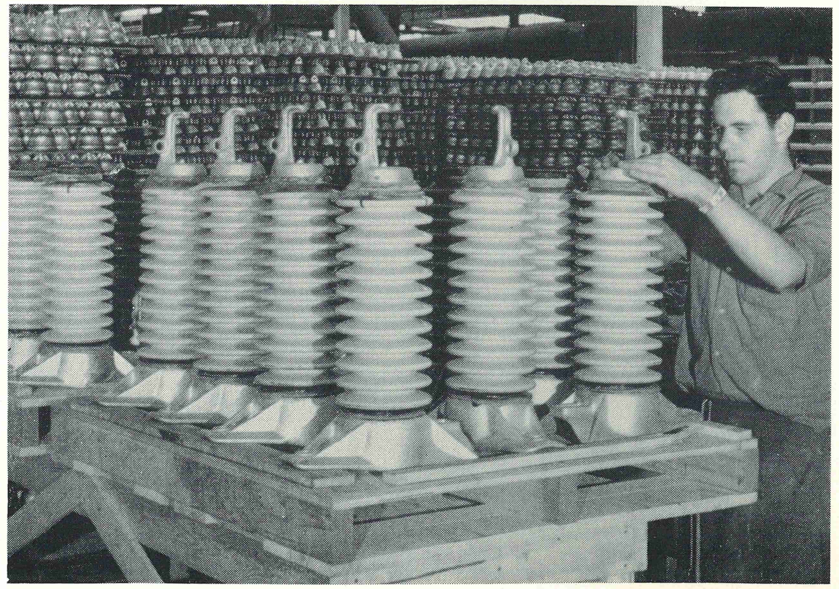
Glazing and application of sand bands to small posts is performed on this automatic reel.



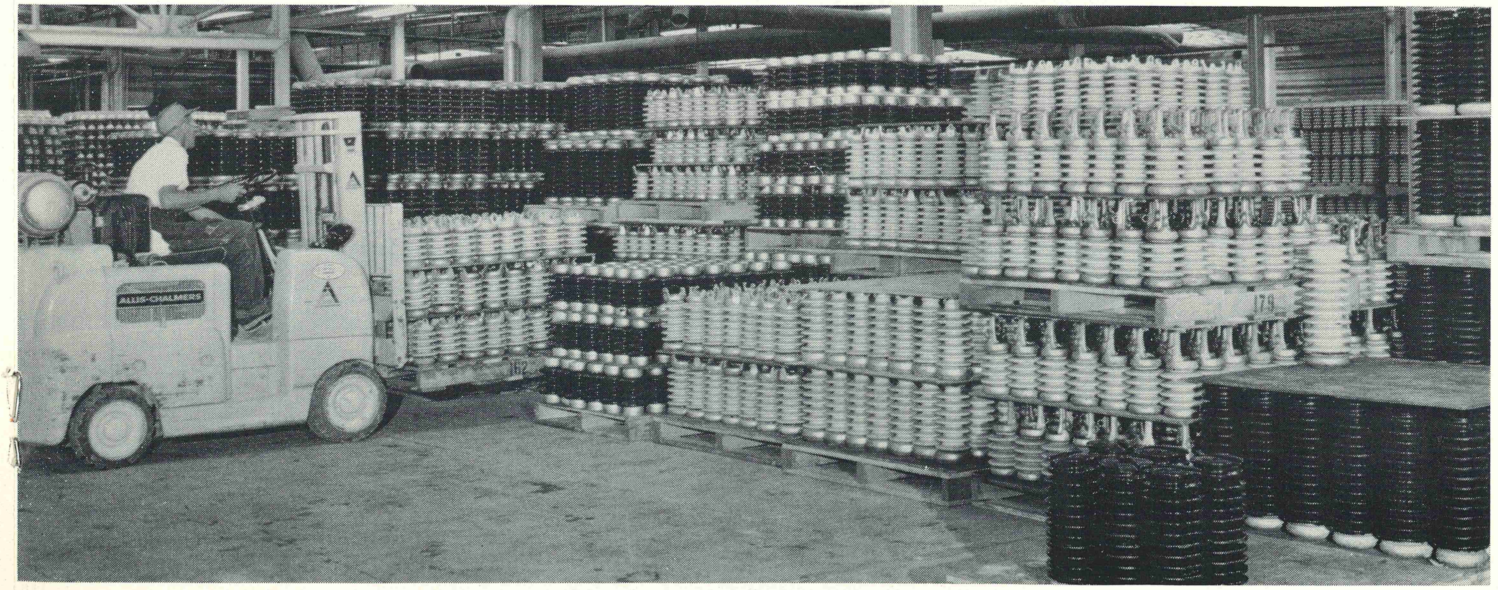
Large station posts receive a final cleaning, followed by glazing inner and outer surfaces.



Small post-type bus insulators are accurately cement-assembled on precision jigs.

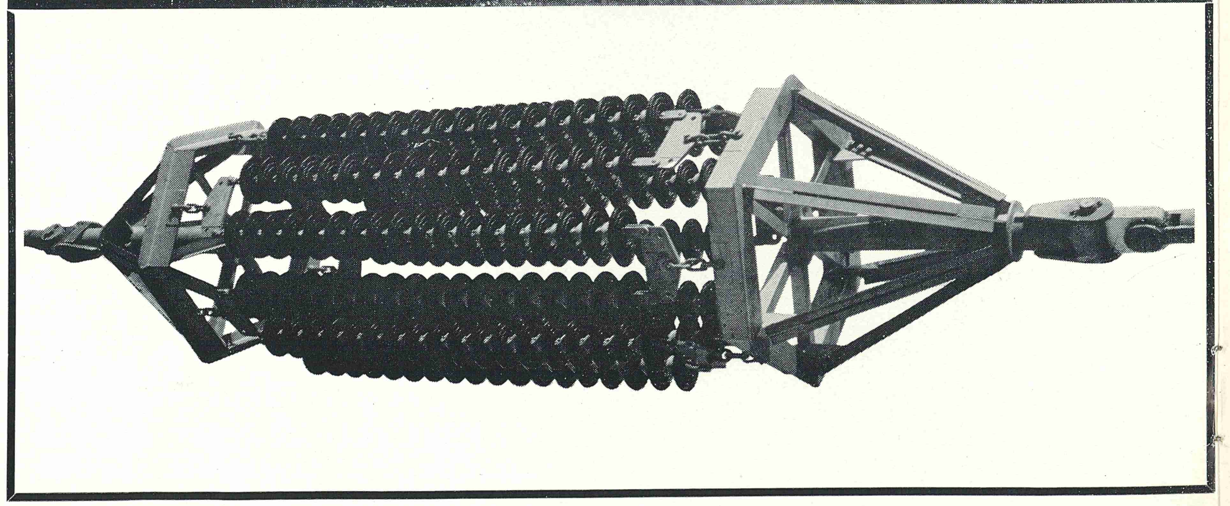


Cement-assembly of horizontal clamptop line posts. Note use of Skytone glaze.



One of several collection areas from which posts are moved to the Shipping Department.

General view of the Kootenay Lake crossing, 10,656 feet between deadend supports, built in 1953. The far bank was favorable for location of a terminal point, being 1,274 feet above water level. The bank in the foreground provided an elevation of only 70 feet above water, requiring construction of a 366-foot suspension tower to raise conductor supports to 436 feet. Minimum clearance above water had to be maintained at 120 feet.



Detail of original Kootenay deadend assembly. Twelve strings of 18 suspension insulator units were used at 170 kv. Rating of these insulators at 25,000 pounds gave the assembly an ultimate strength of 300,000 pounds, and a working strength of 150,000 pounds, providing a good safety factor against maximum computed conductor tension of 106,000 pounds.



# Extra-high-duty deadend has over 20 years' service background

Descriptions of the crossing of the Saguenay and St. Lawrence Rivers on the 735-kv project of Hydro-Quebec have stimulated interest in the somewhat unique insulated deadends employed to meet the high mechanical requirements.

First application of this general design dates to 1953 when the Consolidated Mining and Smelting Company of Canada crossed Kootenay Lake in British Columbia with a 170-kv line. This crossing presented some aggravating problems. One bank adjacent to the lake provided an excellent terminal for a long span inasmuch as it had an elevation of 1,274 feet above water level. The other bank, however, offered ground only 70 feet above water. On this was built a 366-foot tower to raise the anchorage to 436 feet. This had to suspend a span with an unsupported length of 10,656 feet, and maintain a minimum clearance to the water of 120 feet. Obviously, designers were dealing with some extremely high mechanical factors, both as to dead weight and tension.

Conductor chosen for the Kootenay crossing was 91-strand, all steel, 1.25-inch diameter, with a strength rating of 228,000 pounds, minimum. Normal loading was computed at 76,000 pounds and maximum loading at 106,000 pounds per phase. Combined back span and suspension supports at the lower level tower location produced loadings on the deadends of 45,000 pounds and 80,000 pounds per phase under the two classes of strain. On the high cliff side, full strain fell on the deadends and imposed an estimated maximum loading of 106,000 pounds per phase on these devices.

No reliable deadend had so far been devised to handle such loading with a reasonable safety factor. It was for this service that O-B designers developed the 12-string equalized assembly. Use of 25,000-pound insulator units gave this deadend an ultimate strength of 300,000 pounds and a working strength of 150,000 pounds, thereby providing a good margin of safety even under maximum calculated loads. The deadends went into service and performed with complete satisfaction.

The foregoing historical account is to answer various questions regarding details of the service background for Hydro-Quebec's present deadending method.

When this principle was being considered for its recent application, it was placed under design by a specialist group consisting of a power company project engineer and representatives of the structure consultant, cable manufacturer, and Canadian Ohio Brass Company. The final form of the device closely coincided with the original design, with necessary adaptations for the much larger construction for which it was intended.

Insulation consists of 33 clevis type units per string, with 50,000-pound ultimate strength rating, giving the assembly an ultimate of

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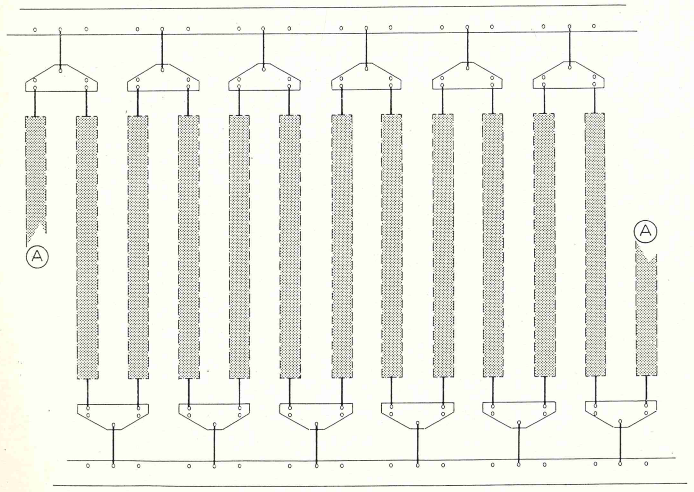


FIGURE 1

**FIGURE 1** Principle of 12-string equalized deadend assembly. When brought to its customary circular form, points (A) are joined. Every string shares uniformly 1/12 the total load, regardless of any slight length variations. Mechanical failure of one string does not incapacitate the device, and less than 10 per cent increase in load is transferred to the remaining strings.

**FIGURE 2** Broken string condition. Note that the two affected yokes go into full strain position and transfer load uniformly to the 11 remaining strings. To replace a string under full strain, tensioning devices are inserted at points B-1 and B-2. Yokes are drawn back to normal position, or slightly beyond, to provide slack so that the new string can be inserted.

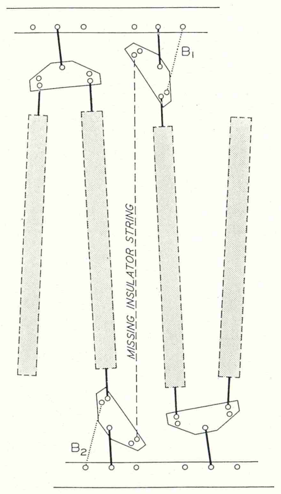


FIGURE 2

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600,000 pounds and a working strength of 300,000 pounds. Conductor consists of a single layer of 23 aluminum alloy strands over a 37-strand steel core. Ultimate tensile strength is 107,500 pounds. Diameter is 1.1 inches. Bundles of four of these conductors per phase are spaced on 18-inch centers.

Class C loading per phase is calculated at 190,000 pounds. This increases to 260,000 pounds per phase with 1½ inches of ice, no wind. These figures apply to the St. Lawrence crossing located a few miles below the City of Quebec, which consists of three spans: a main span of 5,200 feet between 552-foot supporting towers, and two back spans of 2,200 feet and 2,400 feet, making a total distance between deadends of 9,800 feet. The full tension load falls on these deadends.

Deadend assemblies are based on an old equalizing principle, but one that has not previously been applied in such an elaborate form in the support of power conductors. We have trouble keeping people from christening it the "whiffletree deadend" which we feel is somewhat undignified for such an impressive piece of equipment. If we ignore its normal circular shape and stretch it out on a flat surface it looks like Figure 1, realizing of course that points (A) are joined together in practice. It is easy to see how the load is evenly divided between all 12 insulator strings, regardless of any slight variations in string length that might exist.

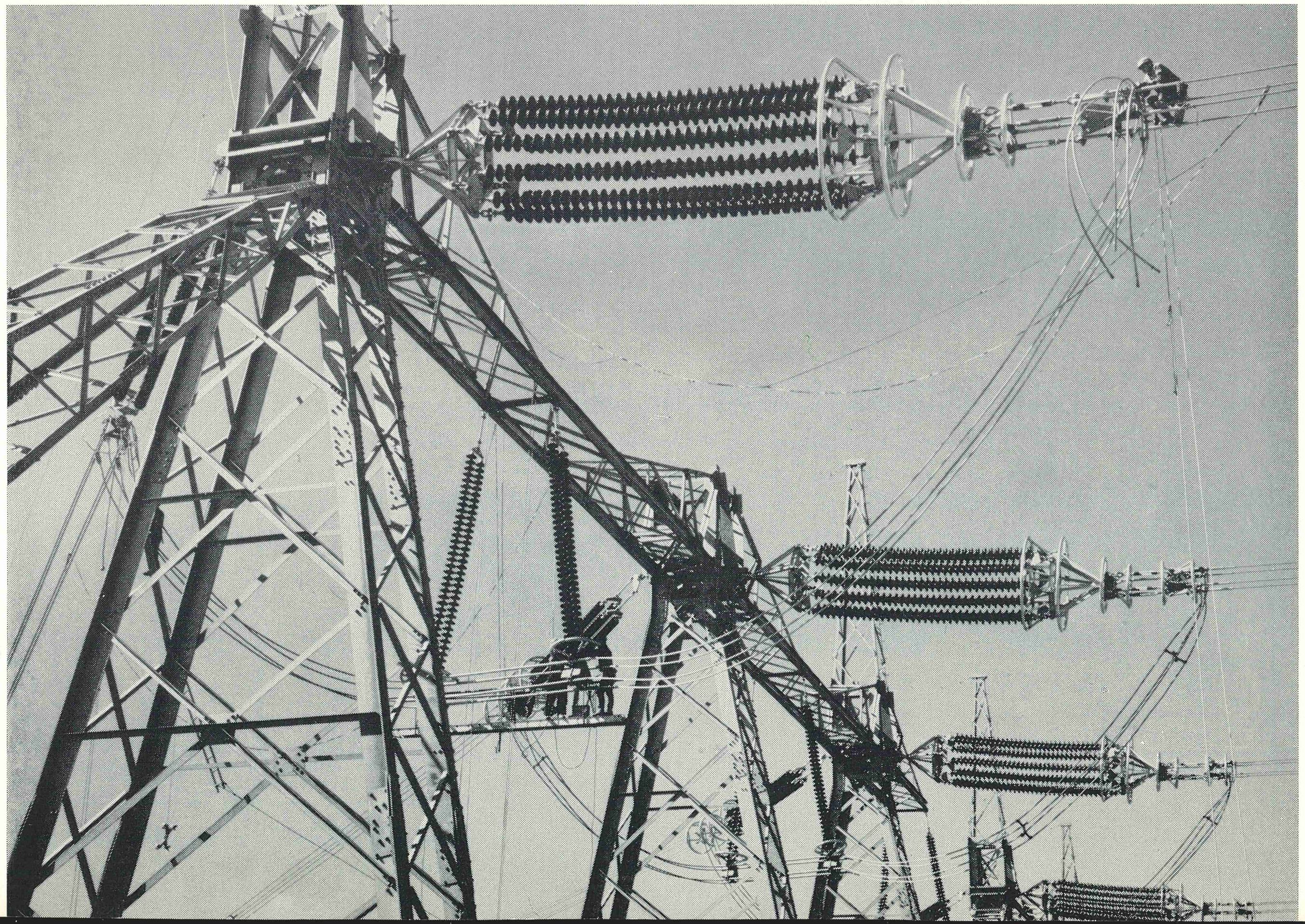
In the event of possible mechanical failure of one insulator string, the two unloaded yokes go into a position of strain as in Figure 2. The deadend is in no way incapacitated and the load on the remaining strings increases less than 10 per cent.

A new string of insulators can be installed under full tension. At points B-1 and B-2, Figure 2, a tension device is installed to pull the yoke back into normal position, or slightly beyond that point, to provide a little slack. The new string is then put in place and tension is restored.

For convenience in installation, the user has the option of installing the deadend with steel rods in place of insulator strings, for lightness, and later inserting the insulation as described.

As "super-EHV" lines continue to grow in size and number, distances between supply and load tend to increase. This always improves the chances of encountering some major crossing. It may be encouraging to project engineers to realize that suitable extra-duty deadends are available in the form of a well matured design with a significant service background.

Completing a jumper loop on the St. Lawrence crossing of Hydro-Quebec's 735-kv system. These deadends, equipped with 12 strings of 33 insulator units rated at 50,000 pounds, have an ultimate strength of 600,000 pounds. Bundles of four conductors per phase on a crossing 9,800 feet between anchorages will impose a calculated maximum load of 260,000 pounds per phase. Weight of one of those assemblies is 16,400 pounds.



# Rural setting offers many advantages for O-B's new Frank B. Black Research Center

Site of the new O-B Frank B. Black Research Center as it look ed at the start of land clearance and grading, August 21, 1967. Within a year a huge electrical laboratory will occupy this land. Its impressive setting in the rolling Ohio countryside is emphasized by the distant view across the Chippewa Valley.

Here's a picture we'll keep in our Memory Book . . . the site of O-B's new Frank B. Black Research Center as it looked on August 21, 1967, at the start of land clearance and grading. In less than a year it will be occupied by buildings housing a huge electrical laboratory.

Ohio, famous for its picturesque rolling country, has lavished its blessings on this wooded hilltop. Looking to the south, one can see for miles over the Chippewa Valley, named for the Indian tribe that once inhabited this section. If natural beauty and peaceful surroundings are conducive to creative thinking, as many people believe, the countryside is a priceless asset to our new research institution.

Located a short distance west of Wadsworth, Ohio, the laboratory will be only about 10 miles from the Barberton plant . . . close enough for easy communication, but far enough to isolate it from the constant diversions that occur when a laboratory is an integral part of a factory complex.

Another facility provided by Nature is a somewhat remote location that will permit certain nighttime electrical tests to be run in darkness; an advantage we do not now enjoy, surrounded by billboards, used car lots, and high intensity street lighting.

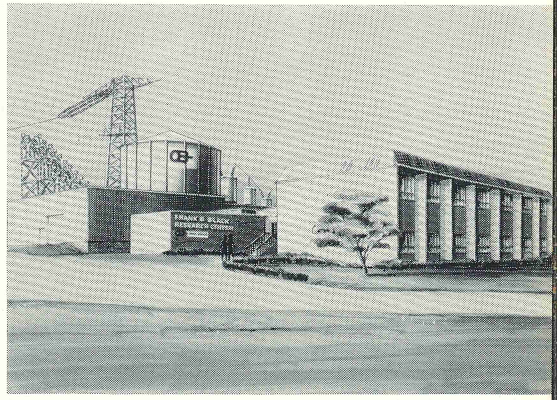
And, above all, we have space. Final testing of transmission lines often requires construction of full-scale prototypes. As lines get bigger, so does the need for more room in the test yard. In the factory district of a city, one has no access to this kind of acreage.

Gone is our source of industrial air pollution, but we will more than compensate for its absence in conducting contamination research. A "silo" 70 feet in diameter by 60 feet high will be built at the new laboratory, giving us complete control over atmospheric conditions. Long-time contamination investigations under natural exposure will still be conducted at the old laboratory. It is felt that air-borne pollution is an increasing factor in power transmission, and O-B's new equipment will greatly expand our horizons and flexibility in this category of research.

In anticipation of voltages in the million-or-more class, as well as the real possibility of direct current in power transmission, the new Research Center will be equipped to conduct all types of testing in these advanced areas of technical study.

Separate sections of the laboratory will be devoted to investigations of lower voltage phenomena as related to distribution and subtransmission. Other portions will be occupied by chemical, physical, and ceramic research departments.

Equipment proposed for the new Research Center is, as would be expected, elaborate. This will be described in later issues of Hi-Tension News.



**OHIO BRASS MANAGEMENT REPORT**

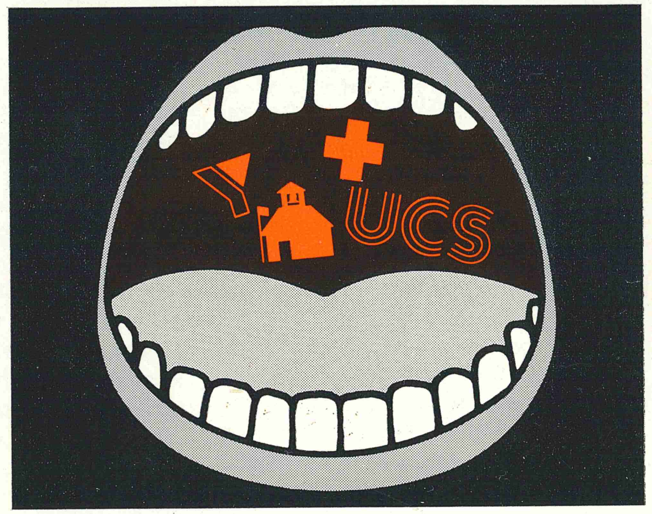
# We risk a few yawns to talk free enterprise

**BY ROGER A. BLACK**
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY

As many other companies do, Ohio Brass has the opportunity to bring teachers of the community to our plant and offices on Business-Education Day. Sometime during the day, the teachers are supposed to hear about the benefits of business operation in a free enterprise system. What do we have to say that is meaningful?

**WE CAN USE** a little history . . . on how a company that started out making harness buckles in 1888, today tests and supplies components for transmission lines up to 765,000 volts. But we'd better move quickly before the yawns begin.
Certainly the growth of the electric utility industry can be cited as a free enterprise success story . . . while other prices go up, the cost of electricity continues to decline. The profit-motive has been working for everyone's benefit. And the manufacturer that helps the utility keep down costs can take part of the credit.

**WE CAN TALK** about service to community . . . Boy Scouts, Red Cross, YMCA, United Community Service and a dozen other organizations which draw on company employees for leadership. They take on these obligations willingly because they want to get involved in community improvement. At the same time we must admit that the problems are growing faster than business, government or the social agencies can cope with them. We must do more, not less, if free enterprise is to survive.




**TEACHERS CAN SEE** our employees at work . . . putting into practice what they learned in the community's schools as they build useful lives for themselves and their families. Perhaps we should remind our guests that at least 40 per cent of the support for public schools comes from taxes paid by industry.

**SO WHAT ELSE** can be said? Free enterprise has not solved all the problems. Mansfield, Ohio, is no Camelot, no fairyland of perfection. We, too, have inflation, social unrest and high taxes. But we have good wages and opportunity for people to make their own success. Perhaps free enterprise and business can take a little credit . . . on Business-Education Day.

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THE OHIO BRASS COMPANY • MANSFIELD, OHIO • 44902
Canadian Ohio Brass Co. Ltd. • Niagara Falls, Ontario, Canada

OHIO BRASS

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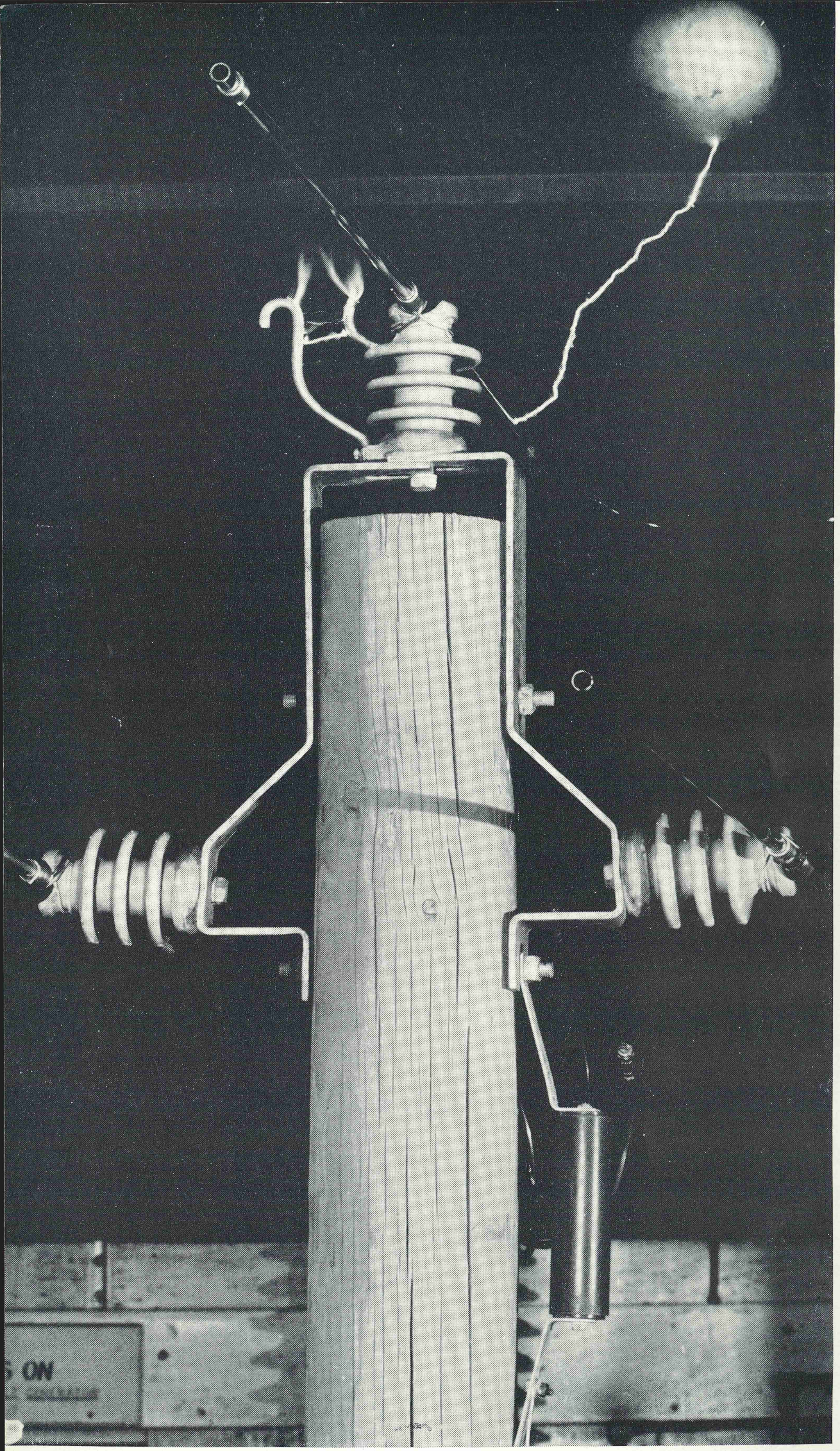
OB Hi-Tension News
JUNE 1968



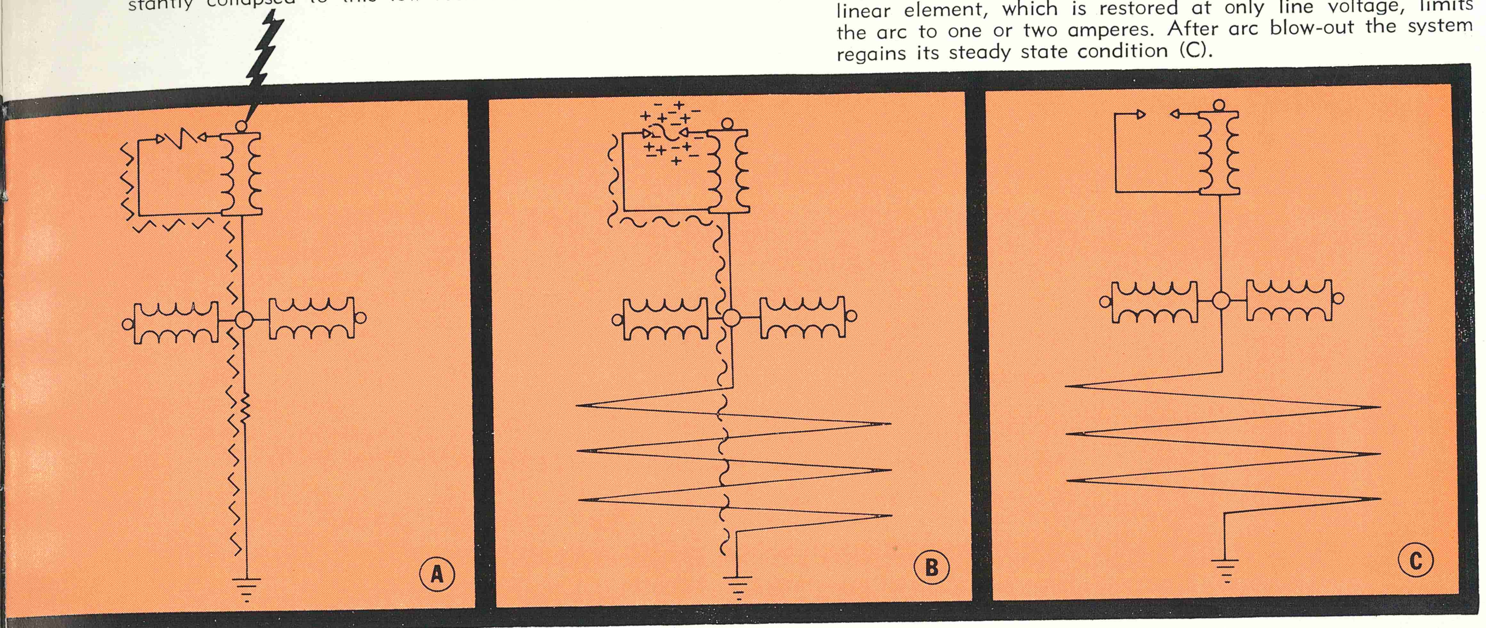
Under laboratory test conditions the three independent actions of lightning discharge, power-follow, and arc extinction occur in such rapid sequence that they produce a composite picture. Note the surge discharge directly across the gap, followed by the rising 60-cycle arc which broke and disappeared during the photographic exposure.


O-B Hi-Tension News
June 1968, Vol. 37, No. 6
THE OHIO BRASS COMPANY
Mansfield, Ohio 44902


**ON THE COVER** — In a district of high lightning frequency, the complete exposure of this Thortec test line makes its trouble-free performance extremely significant.

# Step by step analysis of Thortec lightning protection

Sequence of a lightning discharge. (A) Because of a favorable 30-degree shielding angle, and a gap setting considerably short of insulator flashover, lightning strikes the top conductor, jumps the gap, and goes to ground through a low-resistance circuit. The non-linear resistance element has instantly collapsed to this low resistance state in the presence of high lightning voltage. On cessation of the lightning discharge (B) the ionized gap permits continued flow of system frequency current. As the arc rises, it is stretched and cooled, adding to arc resistance. Within a few cycles, demands of the arc exceed system supply and it spontaneously blows out. In the brief duration of the arc, the high resistance of the non-linear element, which is restored at only line voltage, limits the arc to one or two amperes. After arc blow-out the system regains its steady state condition (C).




In previous articles relating to O-B's new Thortec system of poletop construction, frequent mention has been made of lightning immunity. In answer to several specific questions put to us by prospective users we will cover this subject in more detail.

## System Principles

Basically, Thortec uses elements of two different classical systems of lightning protection . . . with more than a few innovations of its own. First, it depends on shielding, even though it has no separate shield wire. Second, when struck, it discharges the lightning stroke to ground through the classic series combination of a gap and non-linear resistor, even though it has no complex arresters shunting the insulators.

Advantages are several: Omission of the overhead shield wire reduces material and labor, pole height, strength requirements, and general overhead clutter. Multiple-pole discharge paths cope with massive strokes. Location of the rugged protective element in the grounding circuit, which is normally unenergized, adds a strong element of reliability to the over-all system. In addition, there is a degree of protection not normally available even with shielded systems against the effects of indirect strokes.

Equilateral phase spacing provides a 30-degree shield angle for the outside phases, insuring stroke interception by the center phase. The protective element in the grounding lead is a durable silicon-carbide non-linear resistor which readily discharges lightning surges, but blocks ensuing power-follow current to a one- or two-ampere trickle which is self-extinguishing. Thus note the important new principle: Thortec acts not to prevent an insulator flashover from lightning, but to prevent such a flashover from developing into a system fault.

## Lightning discharge sequence

In chronological order, lightning first arcs across the air gap. It next encounters the non-linear resistor whose resistance instantly collapses to a very low value and readily conducts the discharge to ground.

Because of the close setting of air gaps, a stroke propagating on the top phase conductor will be expected to activate additional gaps on adjoining poletops. High stress therefore, is relieved at the point of lightning impact by the load sharing action of participating protective systems. This expedites the surge current discharge by providing multiple parallel paths to ground.

## Reflected waves

Traveling waves have varying rates of rise and time to crest. As these waves encounter an impedance modification at each pole, reflections are generated that reduce the original wave in a multitude of steps. By providing a discharge point at each pole exposed to the stroke current, the surge is readily removed from the system.

## Side-phase flashover

Another factor must also be considered in connection with this lightning protective action; namely, the question of side phase flashover. In addition to the assistance received by the load sharing principle, there is a capacitive coupling between top and side phase conductors. As a result of Thortec's compact design, the coupling factor is in the order of 30 per cent. The side-phase conductors will assume a surge potential of the same polarity as the top phase and common insulator base, and approximately 30 per cent of its value. This directly reduces side-phase insulator surge voltage and minimizes the possibility of flashover.

## System power-follow

Passage of the lightning discharge across the air gap leaves this gap ionized. System frequency current therefore continues to flow. Since this involves no more than line voltage, the non-linear resistance has regained its characteristic high resistance state. With this resistance present in the ground circuit, the arc across the gap is held to a very low current value, not exceeding one or two amperes. This arc rises by heat of convection. In so doing it is stretched and cooled. These actions increase arc resistance and, in only a few cycles, demands of the arc exceed system supply and it spontaneously blows out. For the brief duration of the arc, the amperage it draws is insignificant; thus no fluctuations on the line and no effect on relays or breakers.

## Indirect strokes

Lightning frequently strikes objects adjacent to a line such as fences, trees, and buildings. Depending upon proximity and earth conductivity, a portion of the discharge can reach the ground wire of a pole. This will raise the potential of the pole and insulator hardware to a level that can initiate insulator flashover.

On a shielded line, the shield wire is of no more than marginal assistance in discharging such a stroke. Shield wire surge impedance limits surge current to a low value and encourages a rapid build-up that can cause insulator flashover. This can result in an outage on a line presumably protected against lightning.

Unshielded lines are still more vulnerable. The only relief path for a lightning discharge is over an insulator to a phase conductor that appears as ground to the high lightning voltage. While statistical data are somewhat limited, studies gen-

erally indicate that at least 50 per cent of lightning outages on unshielded rural lines result from strokes that did not actually strike the conductors.

Exposed to indirect strokes, the Thortec system shows a distinct advantage. The upper insulator, because of the reduced flashover of the protective gap, controls the point of flashover. After flashover of the top phase gap, the Thortec resistor limits the surge current attempting to flow up the pole to a reduced value. The resistor action prevents a high voltage build-up on the top phase wire, thus lessening the possibility of additional phase flashovers. This sequence initiates the same protective action involved with a direct stroke; namely, critical gap flashover on adjacent poles, dissipation of discharge, followed by self-extinction of the ensuing power-follow current.

**Service continuity**

Lightning discharge is superimposed on the flow of system current and is dissipated to ground in a few microseconds of time. It has no effect on the continuity of service. The system power-follow current represents an insignificant load and, therefore, is no source of service interruption.

Thortec provides both direct and indirect lightning protection without even momentary loss of power flow. This factor is becoming more and more important as critical industrial processes and computers demand completely uninterrupted service.

**Laboratory demonstration**

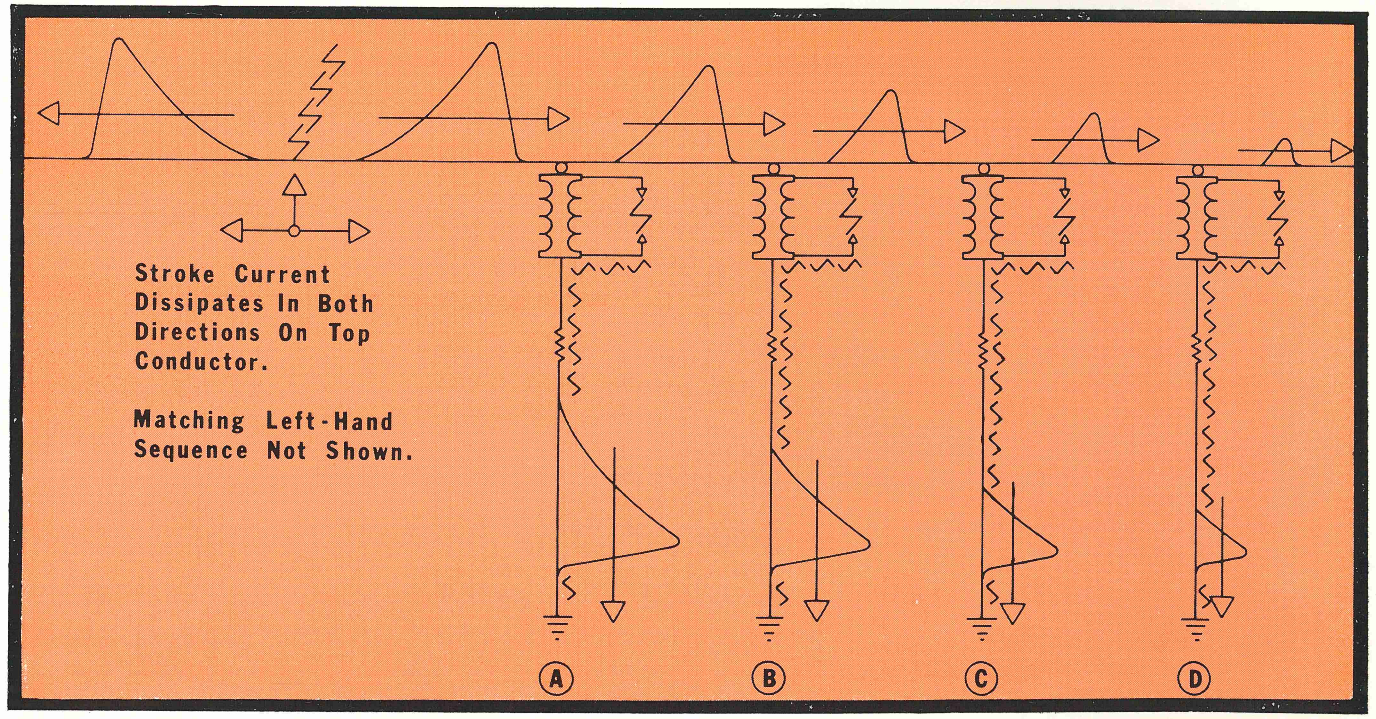
Lightning action of Thortec has been demonstrated in the high voltage laboratory. A specimen poletop assembly is first energized at regular three-phase line voltage. It is then struck by a steep wave lightning impulse. Lightning discharge, power-follow, and arc extinction occur so nearly simultaneously that they produce a composite picture such as shown here. Note these three successive events which are recorded in a single exposure.

**Field trials**

Before general introduction of Thortec to the industry, six test lines were built in widely scattered sections of the country. These lines operated for an investigative period of as much as three years. High lightning exposure was one of the criteria for selecting test locations. During this period of study not a single known lightning outage was recorded.

**Summary**

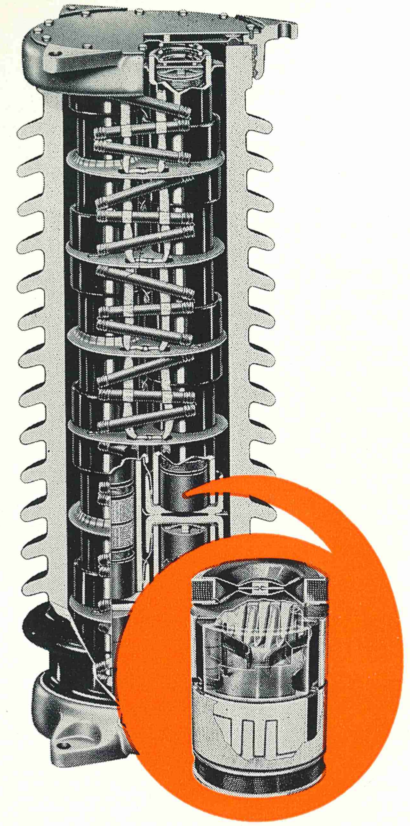
Thortec provides efficient lightning-diverting action at each pole. As a result, either direct or indirect lightning strokes are dissipated at their immediate point of occurrence and, through load sharing of participating diverting systems, are presented with multiple parallel paths to ground. The ensuing system frequency power-follow current in the gaps is of insignificant amperage and duration, and has no effect on service continuity. Protection by means of a series of multiple diverting systems to ground brings a high order of sophistication to the design of modern distribution lines. Note that these advantages are provided without the use of an aerial shield wire or energized protective device.




A schematic presentation of the principle of load sharing of participating Thortec systems during lightning discharge. For simplicity only the active top phase is shown, and no effort has been made to describe the complex pattern of reflected waves. The primary wave propagates in both directions on the top conductor and activates Thortec systems on either side of the stricken point. In the example shown, only one direction of travel is indicated. Each poletop system drains off a portion of the traveling wave until the small remanent will no longer activate one of the gaps and merely attenuates on the conductor. Each Thortec system will independently dispose of power-follow current in the next few cycles.



# Timetable charts of improvements reveal extraordinary progress in station arrester protection



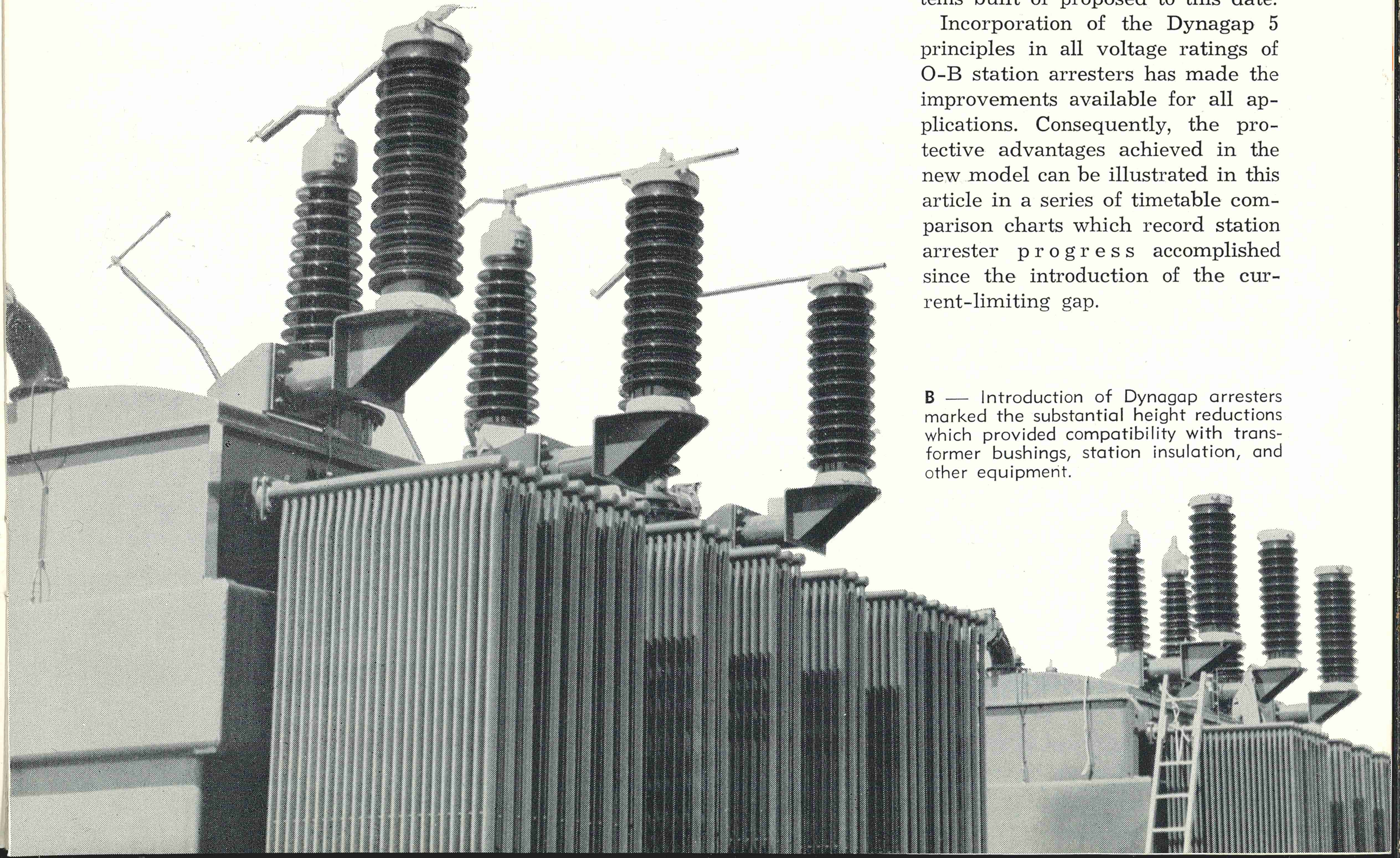
**A** — O-B's Series I station arrester exemplified the most advanced arrester construction prior to the introduction of the current-limiting Dynagap. Its specifications (Series I = 100) are used for the timetable comparisons which show the progression in protective characteristics.

**O-B's Current-Limiting Gap Serves as Basic Design Breakthrough**

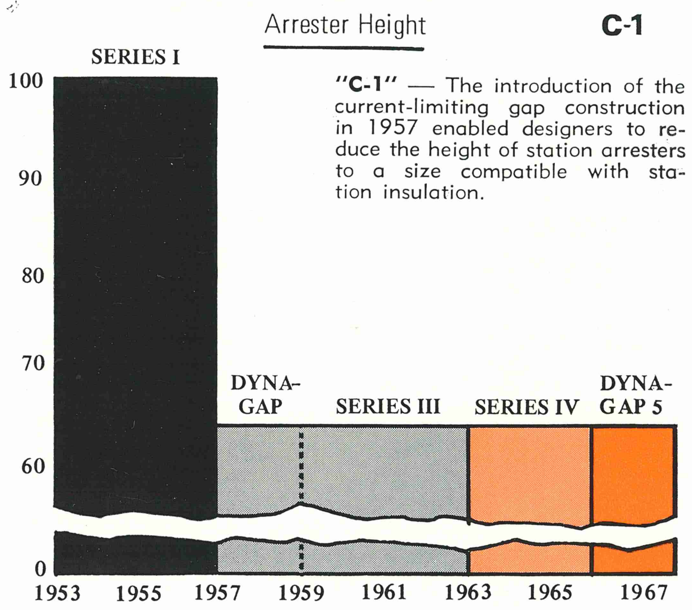
We have now passed the tenth anniversary of Ohio Brass' first announcement of the successful development of the powerful current-limiting series gap for lightning arresters. In reviewing its dominating influence on subsequent surge voltage protective practices, we find that its remarkable capabilities have been expanded at a steady pace to provide the precise overvoltage protection which has made the modern arrester the pivot control for system insulation.

Most recent accomplishment is the Dynagap 5 station arrester, in which sequential controls of the sparkover response circuits have substantially improved its EHV switching surge protective margins. Concurrent major modifications of the series gap structure and its materials have significantly increased inherent arc voltage capabilities in a new "second generation" current-limiting gap (B), thereby adding a completely new measure of arrester durability. Dynagap 5 arrester specifications have been upgraded to exceed the most severe requirements of the highest voltage and longest line transmission systems built or proposed to this date.

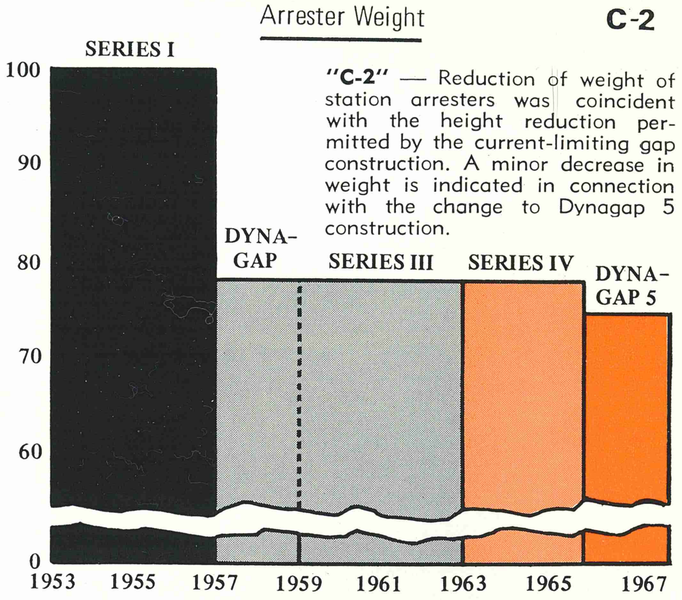
Incorporation of the Dynagap 5 principles in all voltage ratings of O-B station arresters has made the improvements available for all applications. Consequently, the protective advantages achieved in the new model can be illustrated in this article in a series of timetable comparison charts which record station arrester progress accomplished since the introduction of the current-limiting gap.



**B** — Introduction of Dynagap arresters marked the substantial height reductions which provided compatibility with transformer bushings, station insulation, and other equipment.




"C-1" — The introduction of the current-limiting gap construction in 1957 enabled designers to reduce the height of station arresters to a size compatible with station insulation.




"C-2" — Reduction of weight of station arresters was coincident with the height reduction permitted by the current-limiting gap construction. A minor decrease in weight is indicated in connection with the change to Dynagap 5 construction.

Prior to 1957 the most efficient station arresters used advanced forms of magnetic gaps, exemplified for purposes of this comparative study by Ohio Brass' Series I Type MP arresters. Illustration A shows a section of a typical Series I arrester, together with an enlargment of the gap assembly. In its day this arrester was outstanding for its superior protective characteristics, and these values have been charted as the 100 bases for analyzing progress accomplished since that time.

The original Thorex magnetic gap of the Series I arresters had a maximum arcing length of 1.3 inches per kv of arrester rating and the gap contributed approximately 10 per cent to the duty of power follow current limitation, requiring a valve block contribution of the remaining 90 per cent.

The introduction of the current-limiting gap in O-B Dynagap arresters radically changed these proportions. Maximum arcing length was increased to 7.3 inches per kv of arrester rating. The new gap contributed as much as 90 per cent of the power follow current limitation, thereby reducing the responsibility of the valve blocks to only 10 per cent. Former rigid restrictions on valve block composition were no longer applicable and the development of low impedance blocks with a new order of durability was initiated.

The first major benefit of the current-limiting gap to the utility customer was, however, the drastic reductions in arrester height and weight, as shown in the charts C-1 and C-2. For the first time dimensions of appropriate lightning arresters became compatible with transformer bushings and with standard station insulator stacks of either pincap or post construction. Models for all voltages were self-supporting and required no additional suspension systems or bracing provisions.

Single unit housing construction for all MPR arresters was also introduced at this time. Every rating of the Series III Dynagap arrester was contained within a single porcelain housing, functionally continuous from top to bottom. Because leakage currents caused by surface contamination could not enter the arrester's internal circuits as in conventional multiple unit arrangements, the MPR arresters were virtually immune to sporadic, reduced sparkovers caused by voltage unbalances among units.

The improved Series III Dynagap arresters, announced in 1959, incorporated many important refinements of the original current-limiting gap design and were the first to make available the great improvements in operating characteristics. The significant reductions achieved in impulse sparkover, front-of-wave sparkover, and IR discharge voltages are graphically depicted in D, E, and F, respectively.

In 1963, additional refinements were made in the original Dynagap design and important progress accomplished in further reductions of IR discharge voltages. The Series IV Dynagap arresters announced these lower IR discharge voltages together with definite improvements in controls over sparkover response. The increased protective margins obtained were important factors in opening new possibilities for greater reductions in the BIL's of higher voltage transmission systems.

O-B's continuing research and development work in connection with adapting the current-limiting gap principle to severe EHV requirements demonstrated the desirability of major modifications of the original design in order to extend predictability of switching surge sparkovers and further substantial increases in arrester durability. Achievement of these advances was a virtual necessity in providing the high standards of arrester protection specified on some 500-kv and all higher voltage transmission systems.

The decision was therefore made to consolidate these changes into a comprehensive reorientation of the current-limiting gap assembly, which was introduced late in 1966 as O-B's Dynagap 5. The "second generation" current-limiting gap of the Dynagap 5 is particularly noteworthy for its progress in improving sparkover response characteristics and lowering IR discharge voltages along with a reduction in arrester weight as shown in the diagrams of C-1, C-2, D, E, and F. Not shown on the comparative charts is Dynagap 5's great gain in durability, which was accomplished by increasing its ability for rapid generation of arc voltage within the gap structure.

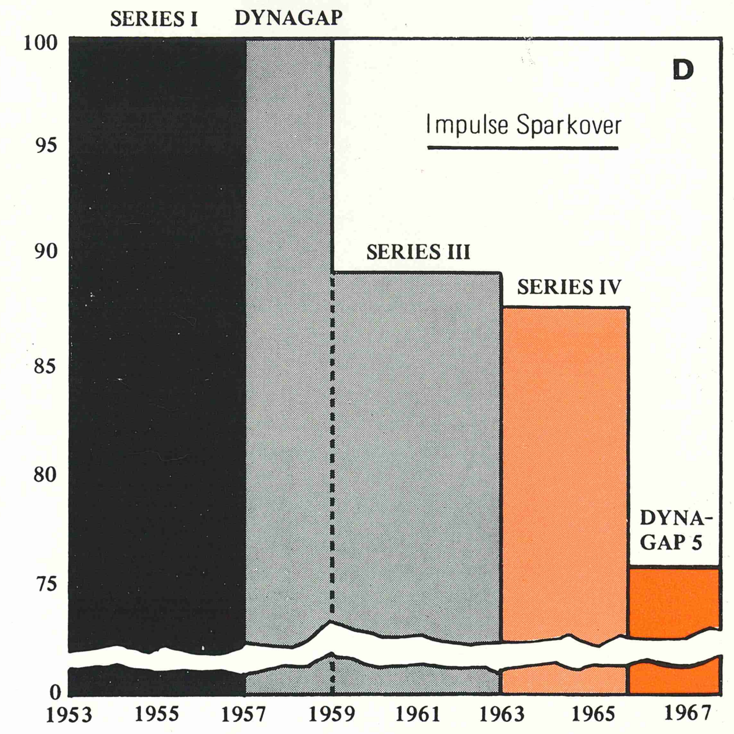
Ohio Brass Dynagap 5 station class arresters incorporate the advanced design current-limiting gap in all kv ratings. While specific benefits may be more pronounced at EHV voltages, the improved operation provides better protective performance at all voltages and a reserve capacity greater than any anticipated requirements.

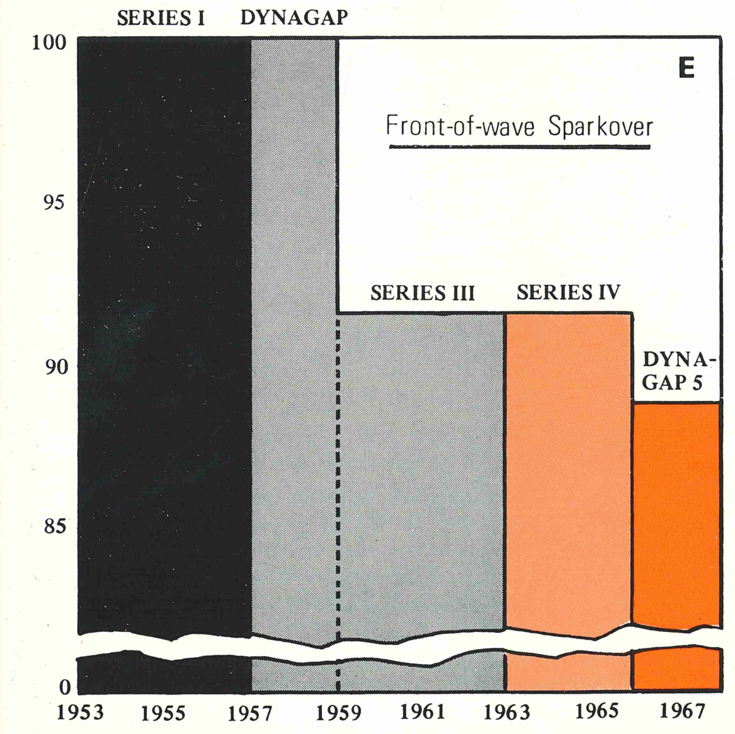
"D" — Full effect of the improved sparkover response of the current-limiting gap construction became apparent in the Series III Dynagap arresters announced in 1959. The next major improvement in impulse sparkover is one of the features of the present Dynagap 5.

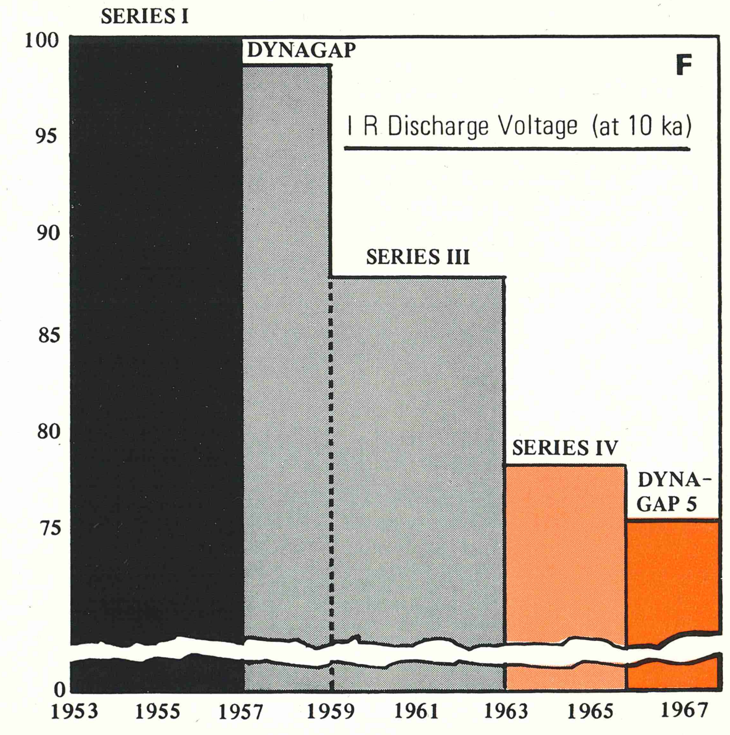
"E" — Front-of-wave sparkover was significantly reduced when the gap grading circuits of the original Dynagap were redesigned to provide the "straight-line" sparkover characteristics of the Series III arresters. A further reduction was achieved in the new component configuration of the Dynagap 5 arresters.

"F" — The improvement in IR discharge voltages is best shown by selecting the 121-kv arrester as a typical rating and comparing progressive discharge voltages at 10 ka discharge current. These discharge voltages are tabulated below:

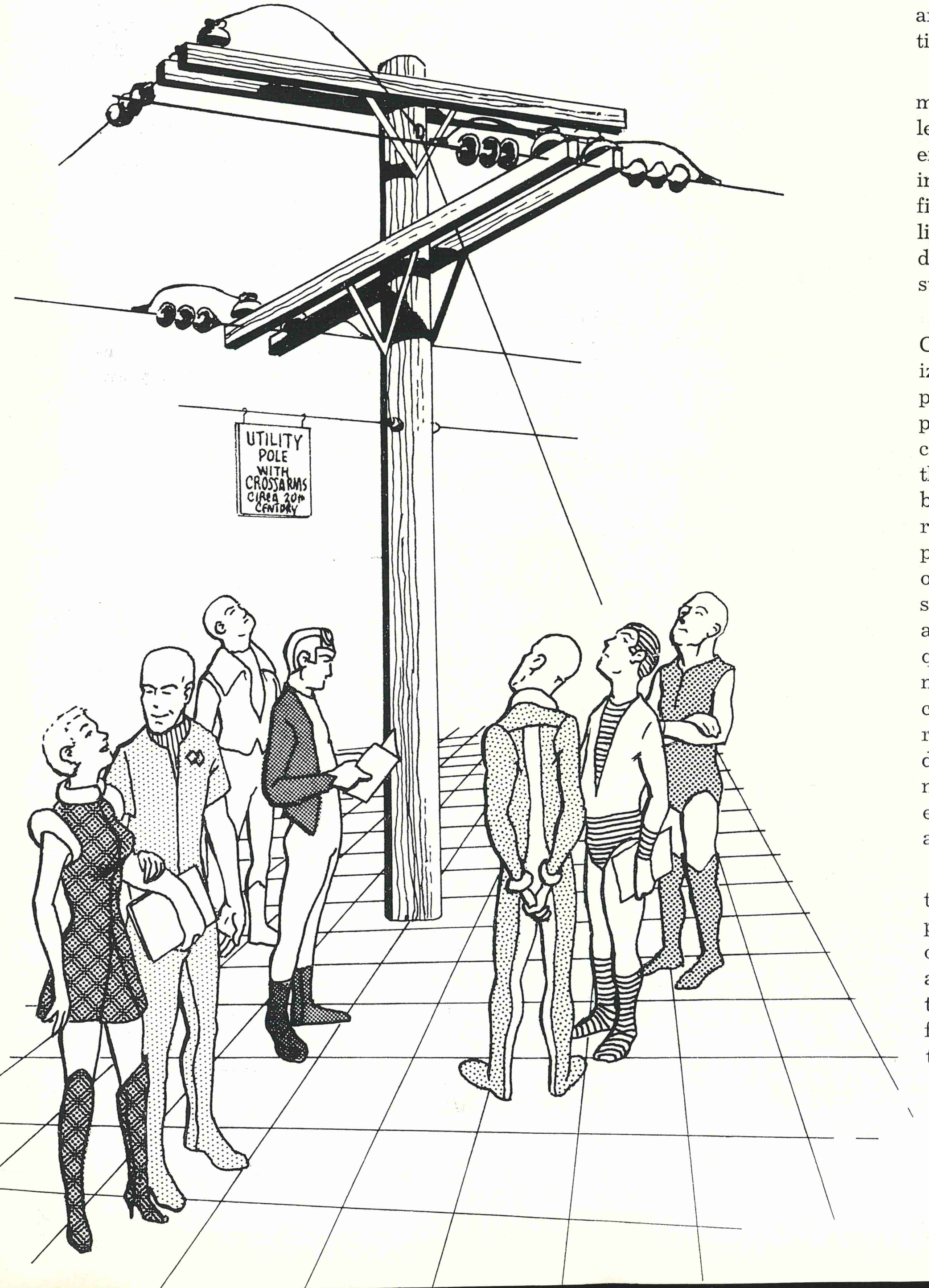
| | | |
|---|---|---|
| Series I | (1953-1957) .............. | 356 kv |
| Dynagap | (1957-1959) .............. | 350 kv |
| Series III | (1959-1963) .............. | 310 kv |
| Series IV | (1963-1966) .............. | 278 kv |
| Dynagap 5 | (1966- ) .............. | 266 kv |



# IS THE CROSSARM A VANISHING ART FORM?



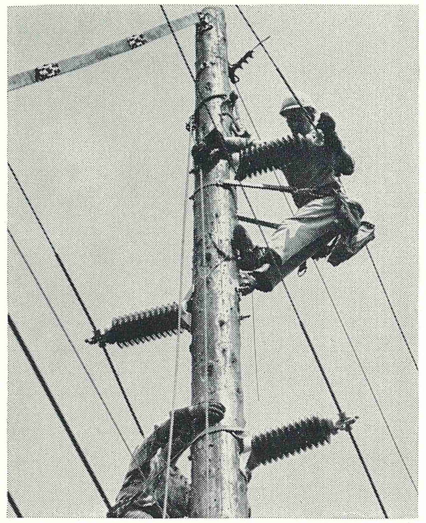

## NOT REALLY - BUT HORIZONTAL POSTS HAVE STARTED A TREND . . .

Perhaps in some future electrical museum, students will point to a sturdy crosspiece of wood, decorated with three or four insulators and assorted hardware, and say, "There it is, right there . . . my grandfather told me about those . . . that's a crossarm!" And everyone will crowd around, marveling at the construction of this bit of history.

Well, that day is not yet. But we must admit the indications are at least in that direction. With today's expanding population and burgeoning economy, utilities many times find the space-and hardware-saving line post the answer when planning distribution or subtransmission construction or improvements.

Whether horizontal or vertical Clamptops, vertical tietops, or horizontal posts with regular O-B suspension clamps, your choice in line posts is wide with Ohio Brass. And, consistent with all O-B insulators, these line posts will provide the best insulation you can buy. The reasons for this are many; first, and possibly most important, is selection of the finest possible clays to ensure traditional uniform quality in all O-B line post porcelain. Thus the quality goes in at the point the raw materials are unloaded from clay cars — and quality control never relaxes thereafter. Posts are produced by a wet process porcelain method that combines stability with electrical and mechanical strength, as well as zero moisture absorption.

All prescribed NEMA and USASI tests are made on manufactured parts of line posts at various stages of production and on all completed assemblies, as are other routine tests which Ohio Brass uses for further analytical investigations. By the time an O-B line post reaches the production stage, you can be sure it has been exhaustively debugged, thoroughly wrung out for flaws, and is the best line post you could buy anywhere, for any price.



**(A)**
The short horizontal posts simplify installation of conductor, as compared to equivalent crossarm construction. The lineman can easily reach the clamp on even a 69-kv post from his position on the pole.

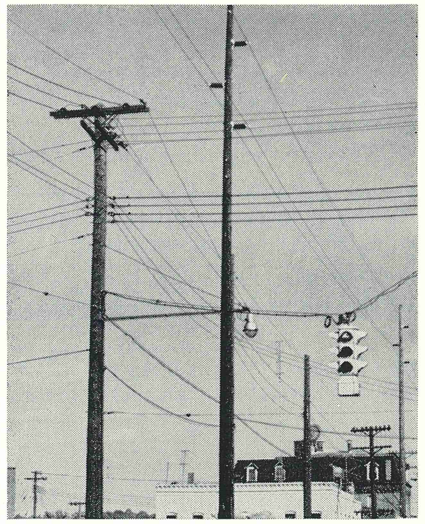
There are certain advantages inherent in horizontal line posts if you have trouble with right-of-way and close-clearance problems. They mount directly on the pole, eliminating the need for crossarms, special hardware, and other insulators.

Water-soluble contaminants are usually easily eliminated, either by natural rain or artificial cleaning, when horizontally mounted line posts are used. Leakage currents are thereby minimized, since there is little probability of bridging from one petticoat to another in the horizontal position. And, of course, horizontally mounted posts mean easier access for the man who has to climb the pole, because all insulators are within easy reach.

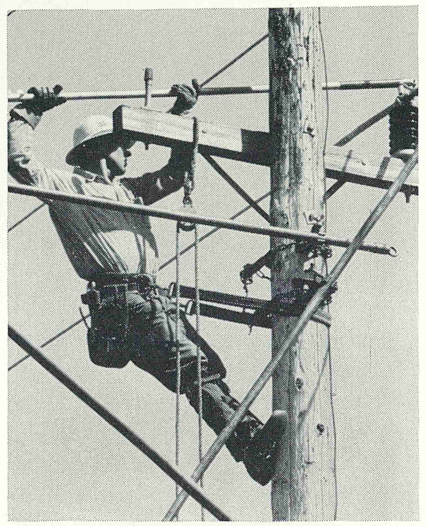
The slight upward tilt designed into O-B horizontal posts keeps pole shrinkage from allowing the insulator to sag below the horizontal. Their mounting bases will accommodate pole diameters from seven to 13 inches, providing almost universal mounting capabilities.

O-B also produces vertical line post insulators with a tie-top head design which facilitates convenient tying and accommodates large diameter conductors. The groove dimensions meet all NEMA and USASI standards. If a more positive means of attaching the conductor to the insulator is desired, O-B offers a choice of vertical clamp-top line posts.

Since the vertical line post does in most cases require a crossarm, we are forced to answer our own question in the negative. No, the crossarm is NOT a vanishing art form. Declining, maybe, getting smaller, but they'll still be around for a long while yet.



**(B)**
Note the considerable saving of space offered by horizontal posts in this 69-kv circuit; occupying less width in right-of-way than the 4-kv feeder beside it.



**(C)**
Short crossarm — but still a crossarm. This vertical line post is easily connected or disconnected by means of hot line tools, when the O-B Clamptop conductor clamp is used.

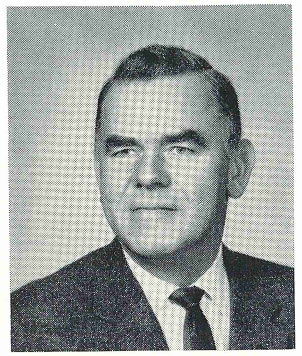
Ohio Brass believes in offering a choice, however. IF electrical construction is traveling in that direction . . . IF your application seems to require horizontal insulators . . . IF you prefer post insulators to other means of insulation . . . you have a series of alternatives. And all these alternatives, in the O-B family of horizontal and vertical post insulators, are completely compatible. You can "mix and match" to suit your individual needs, with the same clamping arrangements available on each type.

So — here's to shorter crossarms. Or to no crossarms at all!

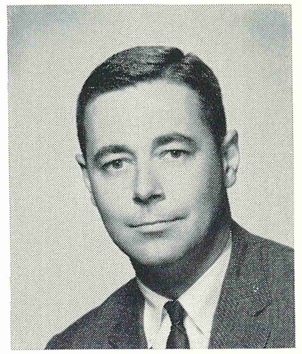
EDITOR'S NOTE: To clarify O-B's position on this controversial subject — we are NOT anti-crossarm. If you have no right-of-way problems, and prefer other types of insulators, remember — Ohio Brass pintypes are available, in virtually all voltage ratings, for every application. It's a matter of choice — and application.

# Ohio Brass names three new directors, three new vice presidents

WILLIAM R. CRESS



JOHN F. MIEFERT



DOUGLAS E. WINTERS

BERNARD H. LITTLE

Three new directors, William R. Cress, John F. Miefert, and Douglas E. Winters, were elected by stockholders of The Ohio Brass Company.

In board action following the meeting, three new vice presidents were named. Miefert, who had been general factory manager, was named vice president, manufacturing; and Winters, who had been executive engineer, was named vice president, engineering.

Bernard H. Little advanced to vice president of finance, treasurer and secretary from his former position as secretary-treasurer.

Elevated to senior vice presidents were Joseph T. Lusignan and Estes C. Thompson who had been vice presidents in charge of engineering and manufacturing, respectively. Cress continues as vice president, sales.

A graduate of Ohio State University, Cress joined O-B in 1948. He served as district manager in Cincinnati and Chicago from 1952 to 1963 when he returned to Mansfield as general sales manager. He became vice president, sales, in April, 1965.

Miefert, a graduate of the University of Cincinnati, came to Ohio Brass in 1945. He served as assistant factory manager in both Barberton and Mansfield, becoming factory manager in Mansfield in 1960. He advanced to general factory manager in 1966.

Also an Ohio State graduate, Winters came to Ohio Brass as a sales engineer in 1957. He served briefly as a district manager in Chicago and then became assistant to the vice president, sales, in 1959; chief engineer in Barberton, in 1963; and executive engineer in 1966.

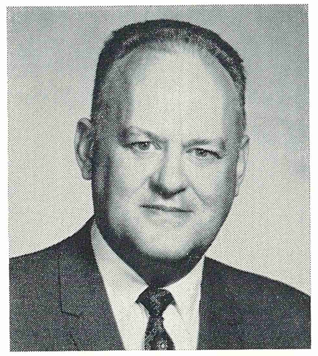
A graduate of Massachusetts Institute of Technology and holding a doctor's degree in electrical engineering from Stanford University, Lusignan has been with O-B since 1930. He became successively chief electrical engineer in 1933; executive engineer in 1938; and vice president, engineering, in 1958.

Thompson served as a sales engineer from 1937 to 1947 when he went to Dallas as a district manager. He returned to Mansfield to become general factory manager in 1956 and was named vice president, manufacturing, in 1958, and a director in 1961. He is a graduate of Virginia Military Institute.

The new vice president, finance, secretary and treasurer, Bernard H. Little, came to O-B as assistant treasurer in 1959 after working for Ernst & Ernst as a supervisor. He became secretary-treasurer in 1960.

# Claude Kingsbury to retire; Paul Ross to take over Seattle Territory

CLAUDE R. KINGSBURY



PAUL M. ROSS

Claude R. Kingsbury, veteran O-B district manager in Seattle, will retire June 30. For 30 years his name has meant Ohio Brass throughout Northwestern U. S. and Canada.

Claude joined O-B in 1927, became superintendent of the Company's High Voltage Laboratory, served as an electrical transportation engineer, and then moved to Seattle as district manager in 1938. He is a member and past president of both the Electric Club of Washington and Northwest Electric Light and Power Association; and is a member of the Electric Clubs of Portland and Vancouver, B. C. Claude is also a member of IEEE and past chairman of the Seattle Section.

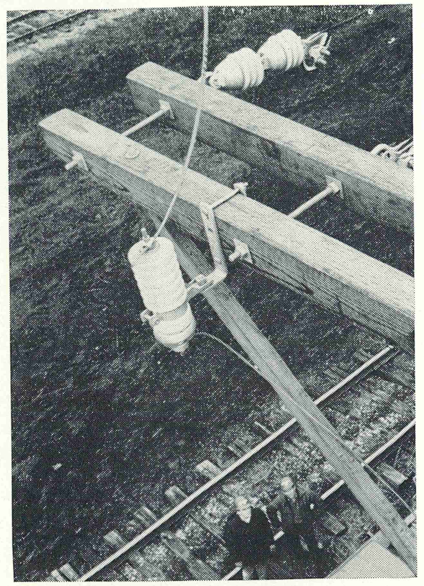
With Claude's retirement, Paul M. Ross has been named O-B district manager in Seattle.

Paul moves to his new position from a long background in engineering and marketing. A graduate of Purdue University, he joined the company in 1934 and, after a series of engineering assignments, became superintendent of the High Voltage Laboratory. For 10 years he managed the high-voltage testing of all O-B electrical products. Then, as a sales and application engineer, he worked closely with O-B customers on their T & D insulation, hardware, and station equipment needs. Since 1959, Ross has been manager of the Power Utilities Department. He is past chairman of the Lightning Protective Devices Section of NEMA and recently resigned as chairman of the High Voltage Insulator Section.

He is already active in the Seattle district.

# A PRIME POINT IN PEOPLE-PROPERTY PROTECTION

## O-B's distribution-class Multirester II with pressure relief provides new safety



There's a lot being said for safety, these days. Manufacturers are inspired into newer and more foolproof safety measures, and people in general are probably safer than they've been for years. That's the point of this article.

O-B station- and intermediate-class lightning arresters have long been available with pressure relief. The company now provides, as a standard feature, the same over-all protection in its distribution-class Multirester II arresters, as further insurance against the unlikely event of explosive arrester failure under extreme fault conditions. We have high-speed movies, taken in the testing laboratory, which show rather spectacularly what can happen when the gas pressure inside an arrester reaches the bursting point, due to breakdown of internal components during extremely high-voltage lightning attack. An arrester without pressure relief may explode, scattering shrapnel-like porcelain shards in all directions.

In all fairness, this doesn't happen every time. Some experts, in fact, believe that chances are about a thousand to one against it. But with the ever-expanding population today, lightning arresters are more and more likely to be installed near heavily traveled areas — near parks, playgrounds, schoolyards — or even close to houses. The thousand-in-one risk increases diametrically with each new subdivision, each new school or shopping center, or with each expansion of electrical facilities.

Strangely enough, O-B's answer to this problem is simply a lightning arrester which succeeds when it fails. Special pressure-relief features, long available in station- and intermediate-class arresters, are now a part of the O-B Multirester II distribution-class arrester. We can now offer this additional protection in every DA arrester.

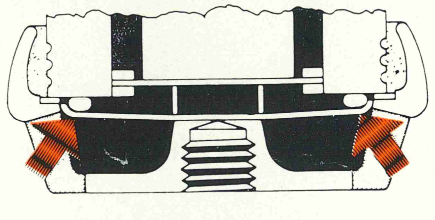
A specially designed stainless steel base plate, or diaphragm, maintains an excellent seal, under normal conditions, in the Multirester II. This diaphragm is cupped upward and is held in place by the strong helical springs which maintain the internal components of the arrester in a rigid position. Violent arrester failure bends the cupped-up edges of the diaphragm away from its seal, allowing the trapped gases to escape harmlessly. In addition, the escape vents in the malleable base casting allow volatilized internal components to be dissipated without being expelled from the base like a projectile.

The same series of high-speed movies mentioned earlier contains sequences filmed showing the performance of the Multirester II under voltages which violently exploded arresters without pressure relief protection. These sequences are not nearly so dramatic, showing only a shower of sparks and a few jets of vapor, or gas, but they graphically illustrate the degree of control made possible by the pressure-relief features of Multirester II.

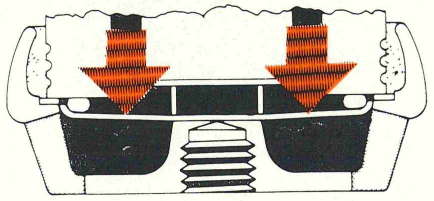
Electric utilities deal, every day, with voltages and forces which are difficult for the consumer to comprehend, let alone worry about. It is up to the utility, in most cases, to institute and carry out protective measures; these measures are mostly not even apparent to those protected. Multirester II with pressure relief is designed for people/property protection, without fanfare. The job of system protection against lightning's attack is done efficiently, with the built-in fault-protective factors inactive until needed.

As we said before — chances are a thousand to one you'll never need them. But they're available in the O-B Multirester II. If you want the finest in distribution arresters, with the only pressure-relief feature on the market, call your Graybar representative or your Ohio Brass district manager and ask about Multirester II.

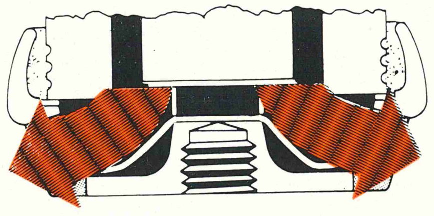
Distributed by GraybaR Electric Company



Under normal conditions, the stainless steel diaphragm is cupped upward and tightly sealed by the compressible neoprene gasket.



Internal gas pressures generated by extreme fault current conditions exert a downward pressure on the diaphragm



. . . which reverses its curvature and allows gases and/or deteriorated components to be released harmlessly through the exhaust ports in the malleable base casting.

# A little education, a little fun go into open house

**BY ROGER A. BLACK**
CHAIRMAN OF THE BOARD
THE OHIO BRASS COMPANY

"With all those machines, they sure have it a lot easier than when I worked here"—from a retiree. "I'd like to spend the rest of my life working in the clay department, then nobody would complain if I got dirty"—from a nine-year-old boy. "I saw 11 relatives on my walk through the plant; that's more than we have at a family reunion"—from a production planner. "I tried to get my wife to go through the Canadian plant 20 years ago on our honeymoon, but she didn't seem interested"—from a foreman. But 20 years and five children later she says: "I'm amazed to see how many complicated operations it takes to make an insulator."

**THOSE ARE** just a few of hundreds of comments made at a recent open house at the O-B Barberton, Ohio, plant, where we make insulators, bushings, potheads, and lightning arresters. The turnout was big as we managed to sandwich the plant visits between the May showers.

**A PLANT TOUR** took over two hours and covered every phase of production. It ended with the showing of a new movie on distribution arresters—THE NEXT MOVE—and a demonstration of electrical phenomena, ranging from a million volts of simulated lightning to a spectacular climb of 60-cycle current up Jacob's ladder.

**BUT THE MOST** interesting part of the tour probably came in the refreshment tent at the end where the comments flowed freely and fast. It was like a homecoming, carnival, do-it-yourself education course, and boasting contest all wrapped into one event.

**FORGIVE US** if we brag a little bit about our employees, but their attitudes certainly dispel any notion that hourly employees are interested in only paychecks. They like money, but they and their families are literally hungry for information on how the products they make are used. They are looking for reasons to be proud of what they do. It's management's job to see they get them.

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THE OHIO BRASS COMPANY • MANSFIELD, OHIO • 44902
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OHIO BRASS

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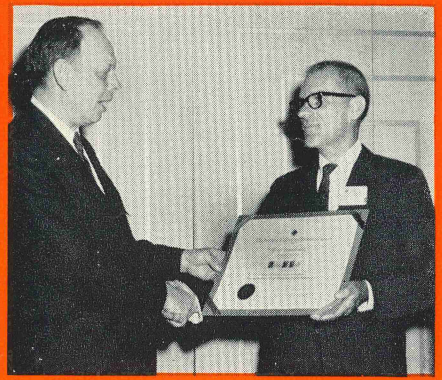
Hi-Tension News

SEPTEMBER 1968

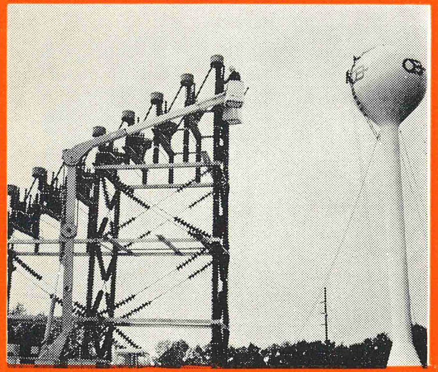
RECEIVED
SEP 10 1968
J. NEUHOFF

## O-B RESEARCH DIRECTOR RECEIVES TOP AWARD AT IEEE MEETING



**Top honors go to J. W. Kalb,** O-B Director of Research, for his IEEE Paper, "How the Switching Surge Family Affects Line Insulation." This is one of two papers selected from presentations over the past five years for its originality and its value to the electrical industry. Leonard J. Linde, left, Chairman of the IEEE Power Group, presents Jack Kalb with a certificate and an award of $200 at the Recognition Luncheon during the Summer Meeting in Chicago, June 25.

## THE COVER STORY



**Finishing Touches** go on the 4,000-kv, 187-kilojoule surge generator, as the O-B monogram takes shape on the 100,000-gallon water tower. Located on a high hill, the water tower pinpoints O-B's new Frank B. Black Research Center from miles away.


Hi-Tension News
Sept. 1968, Vol. 37, No. 9

THE OHIO BRASS COMPANY
Mansfield, Ohio 44902


# Effective corona control . . .

## is a story of details based on a precise relationship of hardware and insulators

**Triple bundle conductor** for 500 kv undergoing corona test at approximately 1,000 kv to permit visual laboratory study. Note that insulators and hardware are the least active elements of the system.

An important step toward greater economy in construction of EHV transmission lines is the elimination of control rings. Rings are costly to buy, install, and maintain. They necessitate larger tower dimensions for electrical clearance. Furthermore, rings complicate hot line procedures.

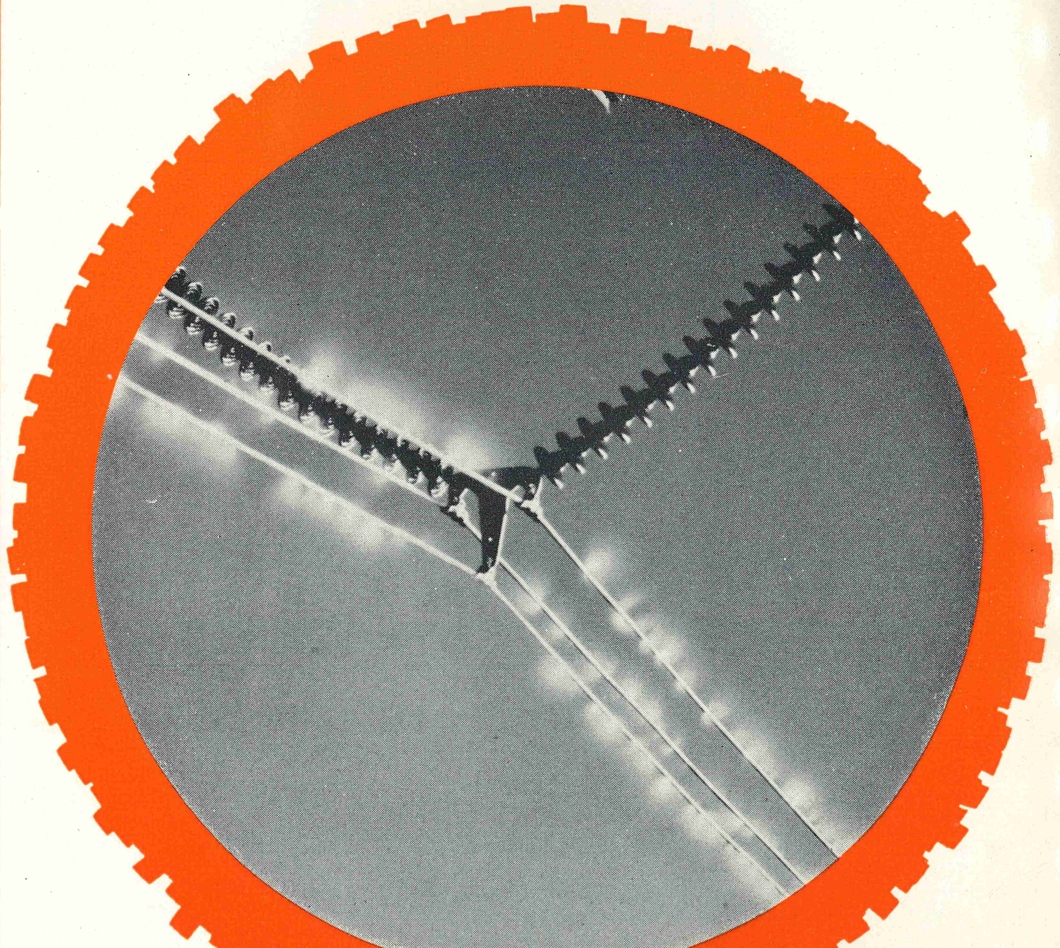
O-B's principle of insulator-hardware relationship inhibits the formation of corona and RIV to the extent that rings are usually no longer required. The originality of this concept has merited the award of various basic patents. It has proved itself effective at all voltages from 345 kv to 735 kv, and is soon to be applied to 765 kv. The great majority of EHV lines today use O-B corona control conductor suspensions.

Rather than resort to some radical new design of conductor support, the O-B system is the result of coordinating a host of relatively minor details. These involve the exact positioning of lower insulator units in relation to the conductor and hardware, and careful attention to small design elements of the hardware itself. By controlling the shape and intensity of the electrostatic field of the connected hardware and insulators, a satisfactory grading of the insulator string is accomplished, and points of concentrated electrical stress on the hardware are relieved. Where hardware components may project beyond the area of effective control, these parts are treated to relieve corona formation.

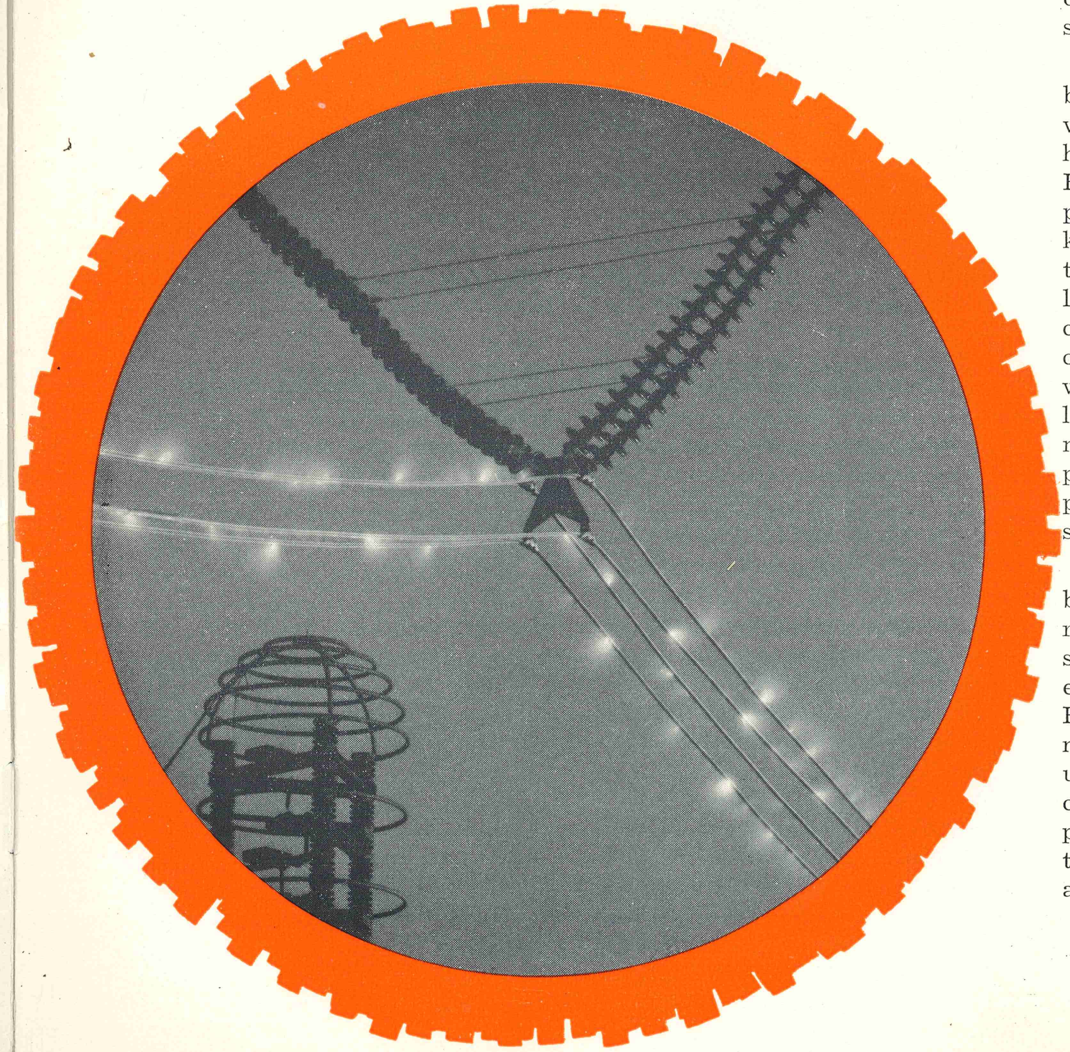
Arriving at designs applicable to various EHV voltages, conductor bundles, and user preferences, was a tedious development project. It could only have been conducted with the immediate availability of a competent high-voltage laboratory, where full-scale experiments could be conducted to investigate theories and prove results. Such development was also aided by the fact that O-B designs and manufactures all its hardware, thus providing a close liaison between engineering minds concerned with the over-all behavior of the conductor support system.

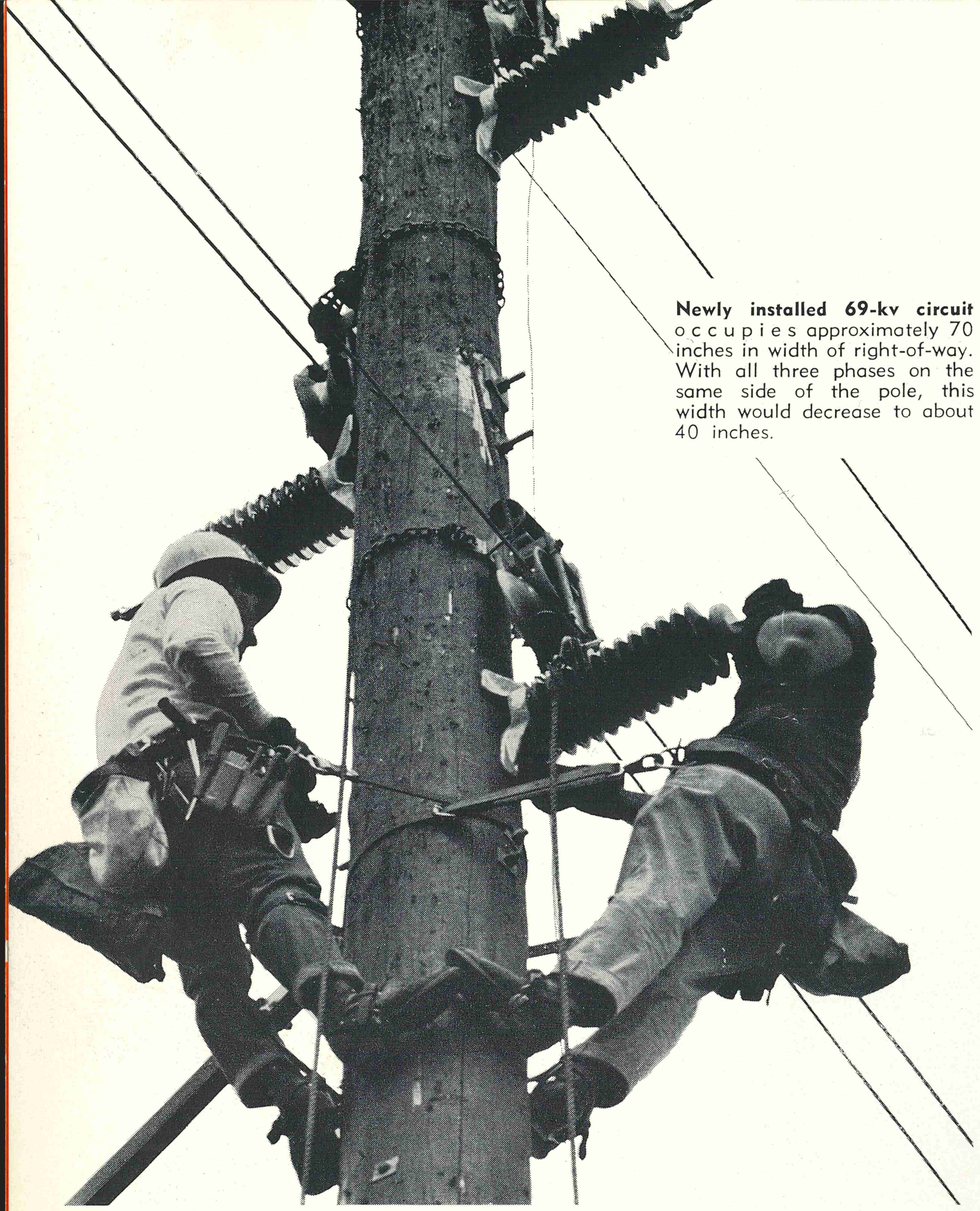
No realistic utility engineer would be impressed by the statement that we have eliminated all corona at high-voltage suspension points. First, he would know this was probably not true. Second, he would know it was not necessary. Every transmission line has its inherent level of corona and RIV on the conductor. The object in O-B's corona control is to keep the hardware-insulator system below the line's natural corona level under normal operating conditions. This property is capable of satisfactory proof in the course of laboratory studies of proposed line design.

Endless development effort has been expended in arriving at precise relationships of hardware and insulators to achieve the present effective control of corona and RIV. Being an exclusive O-B development it was naturally conducted using O-B products. The logical consequence would be to apply this particular combination of materials to your EHV construction for the assurance of optimum results.



**Proposed hardware** and insulator combination under test for 765 - kv service. Voltage has been brought considerably above operating level for corona study.





**Newly installed 69-kv circuit** occupies approximately 70 inches in width of right-of-way. With all three phases on the same side of the pole, this width would decrease to about 40 inches.

## In distribution or sub-transmission construction . . . O-B post insulators

# may well be your answer

Today's steadily increasing population, along with commercial and industrial expansion and electrification, places predictable high demands in electrical service. Complicating these demands is the necessity for providing the requirements while maintaining an equitable level of return, without an increase in cost of service which could affect the rate structure.

Close-clearance and right-of-way problems sometimes make expansion difficult, if not impossible, when you must increase line capacity using crossarm construction. Larger conductors, heavier insulation, and longer crossarms make for extensive installation and construction work — and often the extra space necessary is simply not available at any price.

In situations such as this, Ohio Brass post-type insulators can supply a simple and economical solution. Horizontal posts in particular save space, mounting directly on the pole and eliminating the need for crossarms, special hardware, and other insulation.

Additionally, when used in highly contaminated areas, horizontal posts provide easy elimination of water-soluble contaminants, either by natural rain or by artificial cleaning. The deep petticoating in a horizontal position allows runoff to carry away dust, dirt or industrial deposits.

From a maintenance standpoint, horizontal posts provide easier access for the man who climbs the pole, as all insulators are within reach.

Mounting bases on O-B horizontal line posts accommodate pole diameters from seven to 13 inches, providing a wide range of mounting capabilities. Horizontal posts may be supplied in several variations of Clamptops or regular O-B suspension clamps, and are available from 13.2 kv through 138 kv.

If space is not particularly a problem, O-B vertical line posts may also be specified, in the Clamptop or tie top configurations. They offer the same high degree of freedom from RIV as horizontal posts, due to the wide separation between line and ground. The petticoated surface of the vertical insulator exposes the post to the washing action of rain, as well as providing a large amount of surface beneath the petticoats which is not reached by airborne contamination.

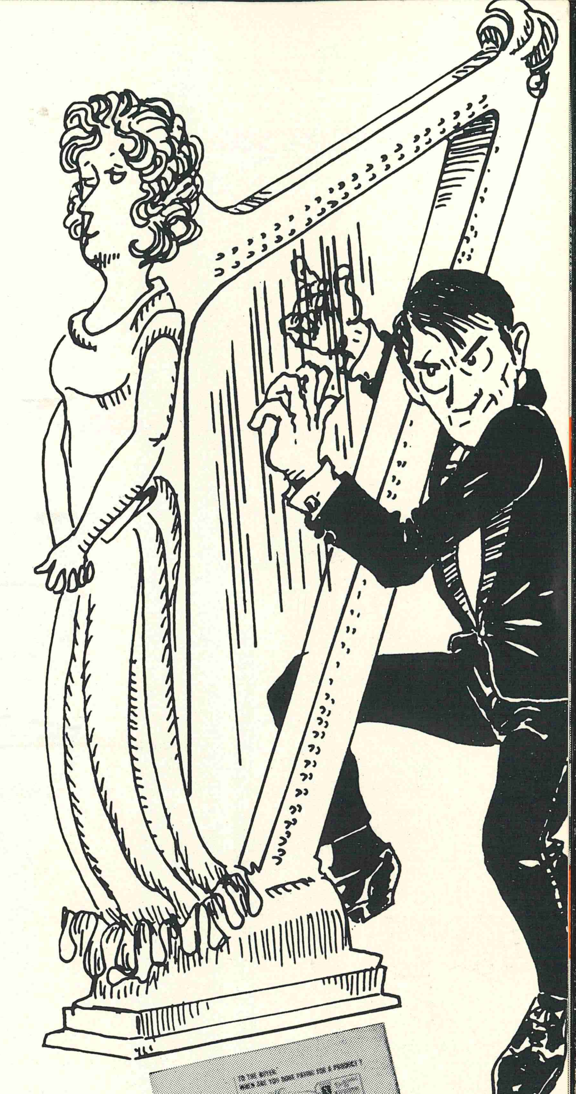
Whether you specify horizontal or vertical Clamptops, vertical tie-tops, or horizontal posts with regular O-B suspension clamps, you have a broad choice in line posts from Ohio Brass. They provide the best insulation you can buy, as do all other types of insulators from O-B.

Distribution posts share the care in engineering, production and testing that has become standard across O-B's product lines, with all prescribed NEMA and USASI tests made at various manufacturing stages. Other tests, above and beyond stated requirements, aid in ensuring that O-B insulators meet or exceed specifications in all cases.

As stated earlier, if you're looking for the answer in distribution or subtransmission construction, look to Ohio Brass. O-B vertical or horizontal line posts may settle the question both efficiently and economically. They can be supplied from stock, in distribution voltage levels, from our Newell post factory. All other line posts are available either from stock or with a short lead time.

## Over the years there's one thing we've kept harping on . . .

# COST OF POSSESSION!



Not that we're angels, necessarily. But we do have one hangup we keep on harping about, and that's how much it costs YOU to keep a large stock of distribution materials in YOUR warehouse.

Looked into it lately? It's called "cost of possession," and it's an apt title. Certainly you know how much occupancy costs you per square foot, what it costs for check-in, check-out, and handling materials within the department. You know what you pay for inventory, stock control, and office expense. Then there's insurance, payroll, breakage, depreciation — the list goes on and on. By the time you total up all the costs, it's obvious there's quite an investment involved. For instance, that 75-cent distribution insulator over there, the one that's been in stock for a couple of years, along with the rest of the insulators in that particular order . . . what did it cost you, really? Before you can estimate that, it has to be put in use; then you figure the original cost, rent, taxes, cost of money invested, for the time on your shelves, all the other incidental costs, and the length of time involved.

Fortunately, there's an answer. In your city, or nearby, there is a Graybar warehouse. We can say this because Graybar Electric Company has warehouses located in over 140 major cities across the United States. And the answer to cost of possession is simply this: let them handle the stocking of your distribution materials.

It's simple. For standard, published prices, Graybar will maintain local stocks of what you want and need. You can get delivery about as quickly as from your own warehouse — with no loss in service or control.

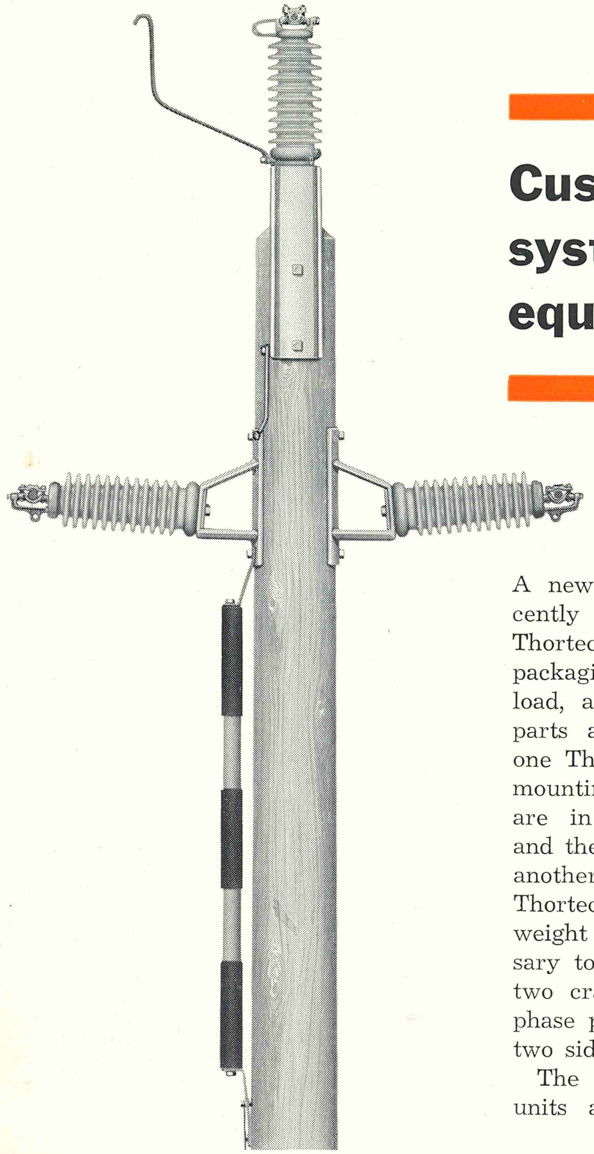
Most local Graybar warehouses now carry a fairly complete line of Ohio Brass distribution materials. O-B insulators, lightning arresters, hardware, and other items are available within a very short time. Your particular needs may not be presently reflected in the inventory at the local warehouse; but consultation with your Graybar representative, outlining your requirements, will ensure prompt acquisition of what you want. Delivery can be made on short notice, almost as fast as from your own warehouse.

Efficient warehousing is an integral part of Graybar's operation. There's no special "stocking" charge for this service, and you aren't obligated in any way. Of course, reasonable material usage would be the normal expectation.

We're not prepared to say exactly what percentage you would save, using Graybar warehousing to handle your distribution materials stock. Some experts have said it's as much as 27 per cent; others state 25 per cent is a reasonable figure; still others say a very conservative estimate would be 10 per cent. Actual costs would, of course, depend on your own operation, and this is where you can take a realistic look and compute for yourself how much you would save. And greater volume of business handled — at lower warehousing costs — would mean greater savings.

Maybe we have been harping on this theme for a good many years. But we've been associated with Graybar for a long time, and when we know about something that will save our O-B customers — and Graybar customers — money, we like to tell them about it. Ohio Brass has the best distribution equipment on the market, and we think a very good way to save purchasing dollars for this equipment is to utilize the Graybar stock plan. Your local Graybar man can fill you in on the details, and tell you how you can make a saving of ____ per cent on your O-B distribution materials.

Only you can fill in the blank in the last sentence.



# Customer-oriented packaging system separates Thortec equipment into poletop units

A new packaging system has recently been put into effect on all Thortec shipments. With the new packaging, it is now possible to unload, at each pole site, the exact parts and insulators required for one Thortec poletop. All necessary mounting hardware and resistors are in one easy-to-handle crate and the necessary insulators are in another crate. In the 46- and 69-kv Thortec installations, due to the weight of the insulators, it is necessary to ship the post insulators in two crates per assembly. The top phase post is in one crate and the two side phase posts in another.

The 15 through 34.5-kv Thortec units are shipped in two crates (hardware in one and insulators in another). All clamptop insulators are shipped without conductor clamps, since these must be ordered separately to fit the conductor size of the specific installation.

All parts are identified and can easily be assembled by referring to the illustrated instruction folder which is included in each assembly.

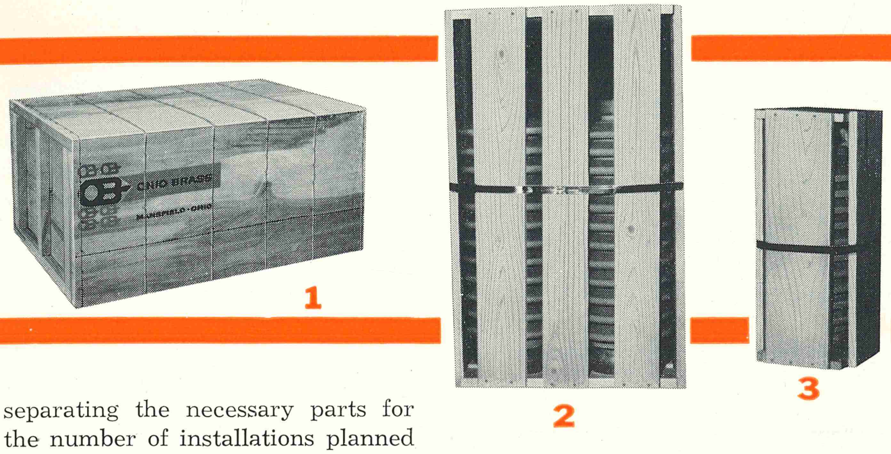
The through-bolts which fasten the insulator mounting brackets to the poles are not included with the Thortec unit package because of the variety of pole sizes to which the assembly can be adjusted to fit. It is, however, particularly important that through-bolts be used in securing the side mounting brackets to the pole, since they must be electrically connected.

This new method of Thortec packaging not only saves time in separating the necessary parts for the number of installations planned for the day; it also reduces the possibility of inadvertently under- or over-estimating the quantity of components, which will be required for the planned day's installation.

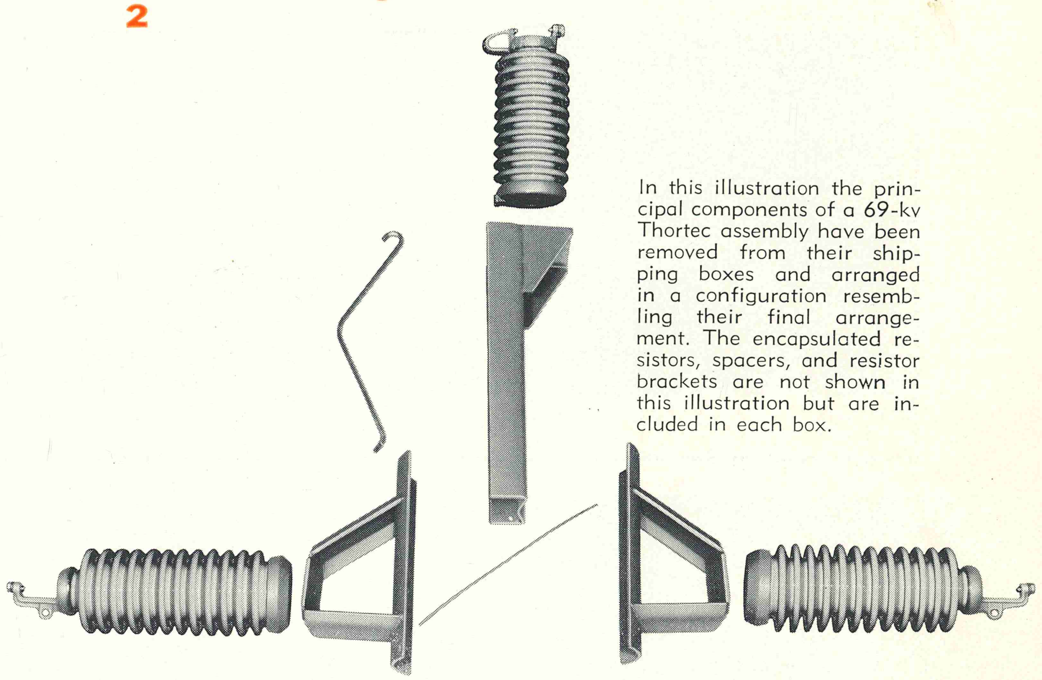
With the compactness of the new Thortec packaging method, warehousing becomes more orderly as the boxes can be easily stacked for storage. There is also less likelihood of losing components such as nuts and bolts.

The accompanying chart shows the sizes, weights, and contents of each Thortec assembly available.

As you can see, O-B has literally taken the guesswork out of handling Thortec, whether it be at the receiving dock, at the warehouse, or at the job site.



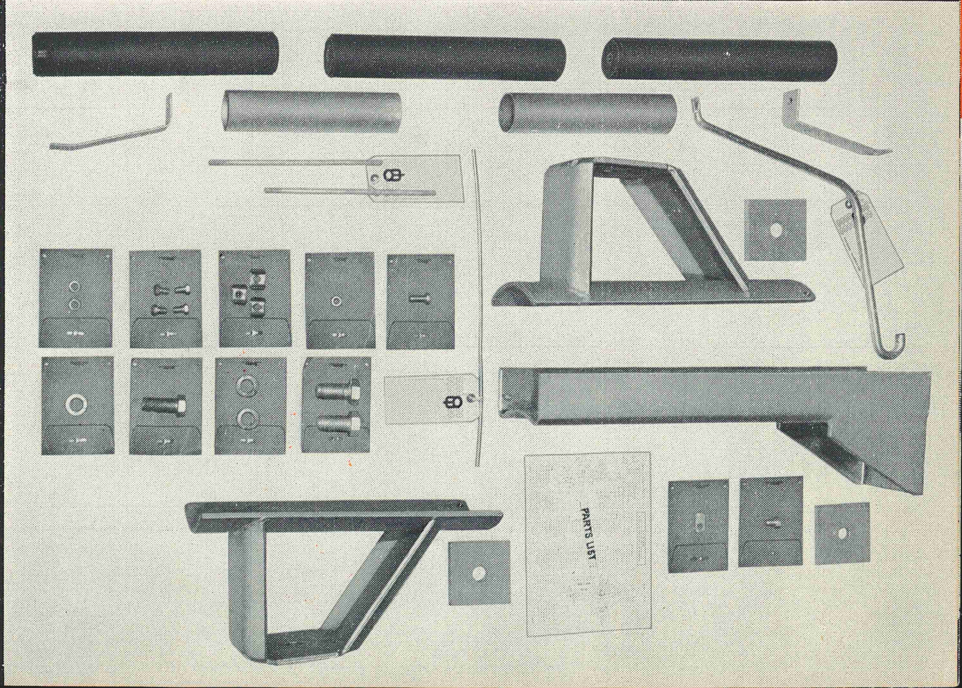

Complete shipping unit for one 69-kv Thortec poletop assembly. Insulators are crated separately from main equipment box which contains all brackets, resistance units, and commercial parts.



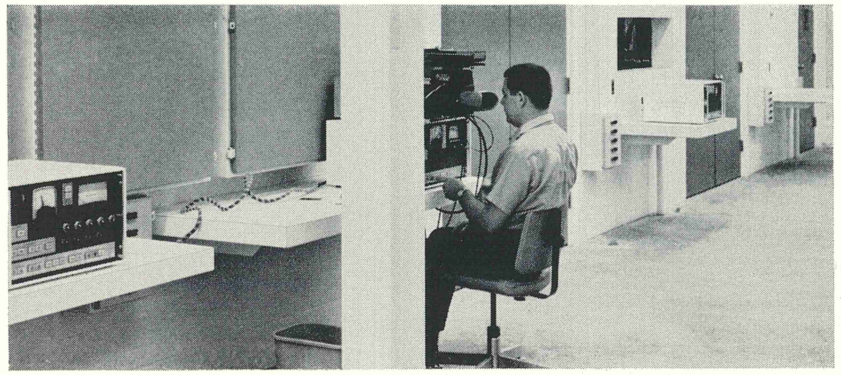
In this illustration the principal components of a 69-kv Thortec assembly have been removed from their shipping boxes and arranged in a configuration resembling their final arrangement. The encapsulated resistors, spacers, and resistor brackets are not shown in this illustration but are included in each box.

| | | BOX NO. 1 | | | | BOX NO. 2 | | | BOX NO. 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| KV RATING | No. BOXES | DIMENSIONS | CONTENTS | | WEIGHT | DIMENSIONS | CONTENTS | WEIGHT | DIMENSIONS | CONTENTS | WEIGHT |
| 15 | 2 | 33″L x 9¾″W x 5⅝″D | 1–Arcing horn (2 with tie top)<br>2–Mounting brackets | 1–Resistor assembly<br>Misc. Nuts & bolts | 30 lbs. | 23″L x 16″W x 8″D | 2–Side phase insulators<br>1–Top phase insulator | 25 lbs. | Not required | Not required | Not required |
| 23 | 2 | 33″L x 9¾″W x 5⅝″D | 1–Arcing horn (2 with tie top)<br>2–Mounting brackets | 1–Resistor assembly<br>Misc. Nuts & bolts | 39 lbs. | 23″L x 16″W x 8″D | 2–Side phase insulators<br>1–Top phase insulator | 28 lbs. | Not required | Not required | Not required |
| 34.5 | 2 | 37″L x 12½″W x 10½″D | 1–Arcing horn<br>2–Mounting brackets<br>2–Resistors<br>1–Spacer | 1–Connecting stud<br>2–Resistor mounting brackets<br>Misc. Nuts & bolts | 68 lbs. | 24″L x 18″W x 8″D | 2–Side phase insulators<br>1–Top phase insulator | 80 lbs. | Not required | Not required | Not required |
| 46 | 3 | 28¼″L x 17″W x 12″D | 1–Arcing horn<br>1–Top phase mounting bracket<br>2–Side mounting brackets<br>2–Resistors<br>1–Spacer | 1–Connecting stud<br>2–Resistor mounting brackets<br>1–Connecting rod (between top and side phases)<br>Misc. Nuts & bolts | 79 lbs. | 24″L x 21″W x 8″D | 2–Side phase insulators | 75 lbs. | 14½″L x 8″W x 8″D | 1–Top phase insulator | 38 lbs. |
| 69 | 3 | 28¼″L x 17″W x 12″D | 1–Arcing horn<br>1–Top phase mounting bracket<br>2–Side mounting brackets<br>3–Resistors<br>2–Spacers | 2–Connecting studs<br>2–Resistor mounting brackets<br>1–Connecting rod (between top and side phases)<br>Misc. Nuts & bolts | 96 lbs. | 32½″L x 18″W x 9″D | 2–Side phase insulators | 142 lbs. | 17½″L x 8″W x 8″D | 1–Top phase insulator | 45 lbs. |

All parts, except the post insulators, for one 69-kv Thortec poletop assembly are identified and packed in the main equipment box. A corrugated carton within the main box contains the three encapsulated resistances, fittings, and all commercial parts.



# Universal combination of test equipment and centralized control are featured in new O-B Research Center



One of the most interesting . . . and sophisticated . . . features of O-B's new Frank B. Black Research Center is the combined testing gallery. In an increasing number of cases it is desirable to link up two or more pieces of test apparatus. This is a serious problem in the ordinary laboratory due to location of equipment and its controls. Here, the facilities for combination are built in.

Leading off a long hallway are several large totally enclosed areas, each heavily shielded against accidental explosive failure of test specimens. Observation of tests is made through windows equipped with safety- or bullet-proof glass. These rooms contain the following apparatus: A 220-kilojoule, 10.5-kv, 4,000 microfarad surge generator. A 150-ka surge generator. A 10.5-kv, 28-kilojoule, 500-microfarad surge generator. Sources of both a-c and d-c high-power testing voltage.

Each piece of apparatus naturally has complete electrical control equipment in its own room. However, this control is monitored by a small, portable, miniaturized console. For individual tests the console is plugged into an outlet outside the room in the main hallway. Each of these control locations has plugging accommodations for any or all of the consoles monitoring each piece of apparatus. In this way, if two or more pieces of test equipment are to be combined, the consoles can be assembled at the most convenient point and all operations controlled from a single station. Special reading and recording devices can then be added to provide total instrumentation of the most complex test from any one location.

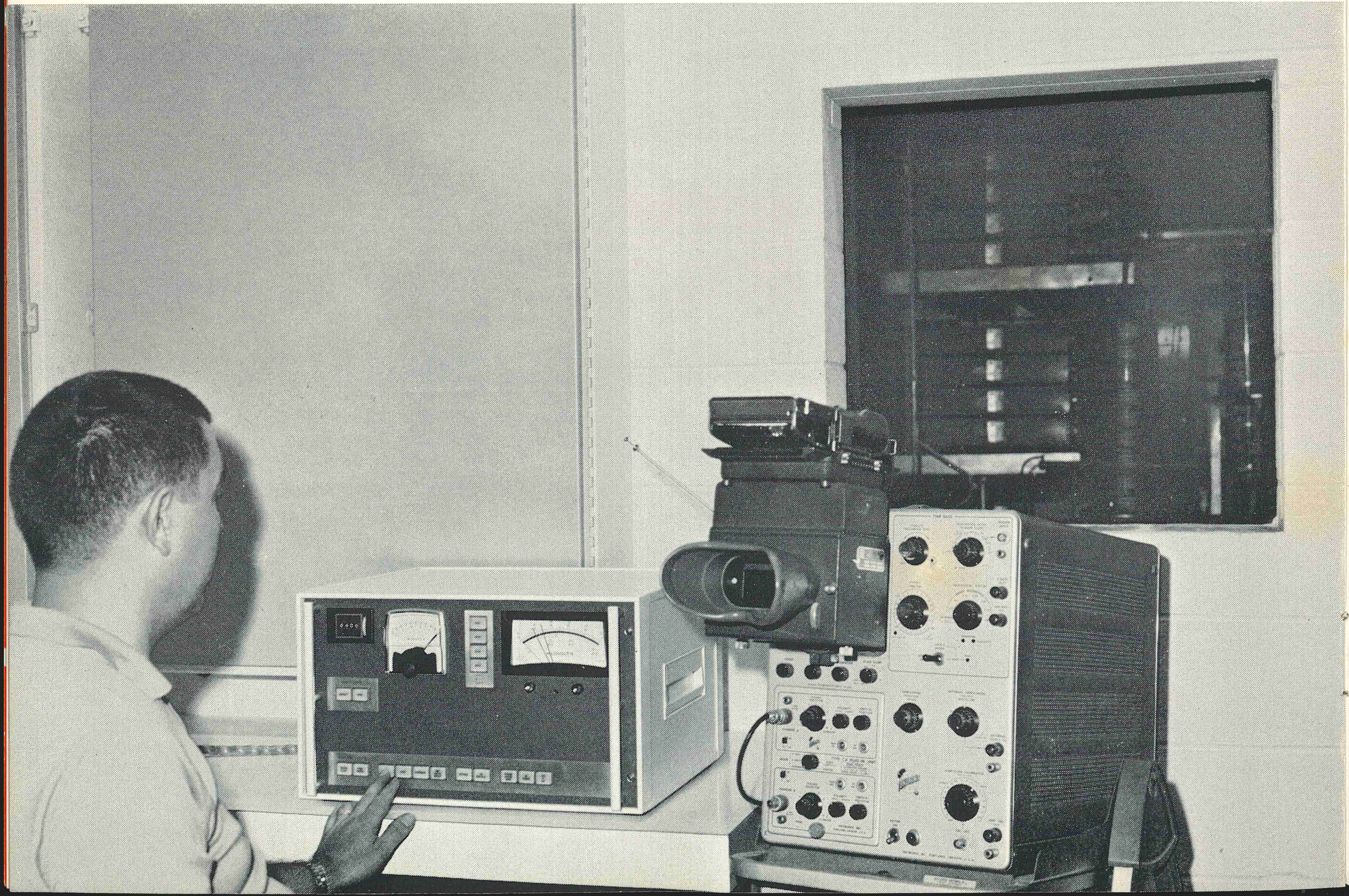
Augmenting this combined control is a system of busses that permit interconnection of all equipment.

Flexibility of testing with this new setup will be practically unlimited. Moreover, the complicated questions of combination and control are now strictly routine.

A huge new laboratory is a serious undertaking for any company and represents a major investment. Nevertheless, there are human beings involved and they are getting a "big bang" out of their spanking new workshop. The wiring diagram for controls in the test gallery looks like nothing so much as a dish of spaghetti. Who is interpreting this maze into panels, relays, switches, contact strips, multiple outlets, and what have you? Not exactly run-of-mine electricians. One day the "work force" consisted of a Research Engineer, O-B's Vice President of Engineering, Chief Development Engineer, and Director of Research, all in their work clothes, pulling in and connecting the miles of control wiring. And if the system doesn't work, the understanding is that alibis will be accepted in inverse order of protocol.

Not only is the new Research Center a big, complex machine, but it is also undoubtedly the most beautiful institution of its kind now operating in the industry. Interior decorators have determined color schemes of the different offices and laboratory areas. And there's a bit of kidding going on about the testing gallery. Walls are in a soft off-white. Doors into apparatus rooms, for color relief and easy visibility, are painted blue. Well . . . Wadsworth is on the edge of the Ohio Amish territory. Hearsay has it that the Amishers paint their gate blue when they have a marriageable daughter. There may be a question as to what is going on down in our test gallery.

By the time you read this a large portion of the new Research Center will be in operation, and the rest will be near completion. It is easy to find. Just go to the intersection of Interstate Route 80S and Route 57. The laboratory entrance leads off Route 57 a few hundred feet north of the interchange. Simply look for the big water tower with the "O-B" monogram. You are cordially invited to stop in and take a look if you are driving through this part of the country. The latch string is out!



◀ **Laboratory technician** operating one of the portable control instruments in the combined testing gallery. Where two or more pieces of test equipment are connected, these portable controls can be assembled at a convenient central location to permit supervision from a single point.

**Adjacent to each piece** of equipment in the testing gallery is a plug-in panel permitting connection of any or all control stations at this point. Complete centralized supervision of all apparatus is thus possible, regardless of combination. ▶

# LINE TRUCK WEIGHT SHIFTED FORWARD


AN ARTICLE BY
PAUL W. ROOF

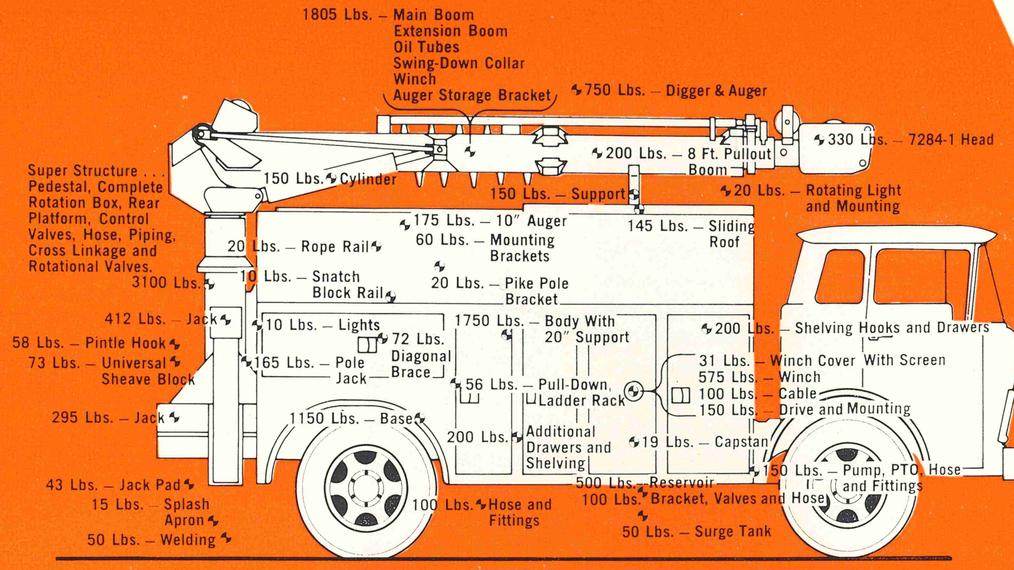
Paul W. Roof, Director of Transportation, American Electric Power Service Company, Canton, Ohio



Reprinted from Electrical World with permission of author, May 27, 1968


Line trucks on our system are working tools expected to perform almost every job a line crew encounters. The increasing sophistication and versatility of modern equipment has brought welcome solutions to many of our problems, but created a serious one as a by-product. Our average rear axle loadings went from 16,000 pounds a few years ago to more than 22,000 pounds on our new fully equipped units. This not only exceeded manufacturer ratings, but also put us above legal limits.

At first, we tried to use a longer chassis to redistribute the loading. Then a short CA chassis with a higher axle rating was tried, but we still had not solved the problem satisfactorily.




**Detailed weight analysis** supplied by the manufacturer for a specific vehicle provided the information that helped us shift much of the weight to front axle

We then faced a choice of developing one specialized unit for each division — transmission, distribution, and stations — employing smaller units with specialized functions to do one job only, or developing a new universal unit to meet all our needs with redistributed axle weight. We decided the one universal unit would be the most economic solution if it had built-in flexibility.

Research began with a detailed analysis of just what we needed in a line truck. We looked at chassis, bodies, derricks, optional equipment, safety features, and cab sizes. Our basic requirements included room in the cab for four men, a minimum GVW of 27,000 pounds, a derrick to reach 32 feet, a flexible-design modular-body with capacity to carry our standard package of tools and equipment, and a chassis maneuverable enough to get around equally well in town and country.

Specifications for the chassis were developed first. We required a 120-inch CA, tilt-cab chassis with the power to pull the full 27,000-pounds along at highway speeds. The front-axle carrying capacity had to be between 12,000 and 14,000 pounds. Duplex or flotation tires were necessary front and rear of the same size which would track in-line.

Design of the body to fit our needs required some detailed engineering work. To achieve our desired shift of axle weight from the rear to the front axle, heavier tools and material must be stored up front. Storage of material in the superstructure was limited to eliminate any top-heavy tendencies. We also determined that we needed the flexibility of modular-body construction to permit us to add or take out compartments to adapt specific trucks to specific crews.

For the general line-truck body, we placed the rubber goods through compartment toward the front. Locating these often used items at ground level on the side provided conveniency and safety. Next, we included a compartment for storage of heavier tools and equipment, such as chains and hoists. This same idea is followed on left and right sides, except the winch compartment.

On the right side of the body, the second compartment is a winch compartment. Flexibility of design in the modular body allows us to position this winch compartment in any one of the three locations toward the front of the body. We selected a 20,000-pound capacity winch with a 23-inch drum for use on the new universal unit. A slotted separator installed at approximately 18 inches from the anchor end of the winch permits us to wrap nearly 300 feet of ½-inch cable in the 18-inch drum, yet have the necessary capacity on the 5-inch section to assist the truck in muddy and rough terrain. Controls for the winch are located inside the cab as well as at the rear console for just this reason.

Design of the base frame permitted us to mount the derrick at the right or left rear corners, or center forward of the rear axle. We needed a derrick with at least a 32-foot reach, lift capacity of approximately 9,000 pounds, and digger-torque withstand capacity of about 7,000 pounds-foot. This gave us a full selection of prospective manufacturers, so we requested details on actual weights from several. A comprehensive study of line-truck weight is presented in the line sketch above for the Holan Mustang 72 unit which was finally purchased.

As a result of the detailed weight analysis, we were able to shift an additional 2,000 pounds from the rear axle to the front over our original estimates. One significant move was to place gasoline and oil tanks at the extreme front of the chassis. Secondly, we repositioned the outrigger-stabilizer jacks. From placement behind the pedestal on the tail shelf — 48 inches behind the axle — the right-hand jack was moved up even with the pedestal, while the left-hand jack was moved forward approximately 20 inches. The over-all effect of redesigned body, movement of the tanks, and repositioning of the outriggers gave us estimated front axle loading of about 11,000 pounds and rear-axle loading of about 16,000 pounds.

With the help of the manufacturer, final drawings were developed for the new line truck and submitted to management and operations personnel for approval. This was accomplished quickly, and with very few objections. One important addition was made through the recommendation for inclusion of a drop-down rack assembly for convenient ladder removal and storage.

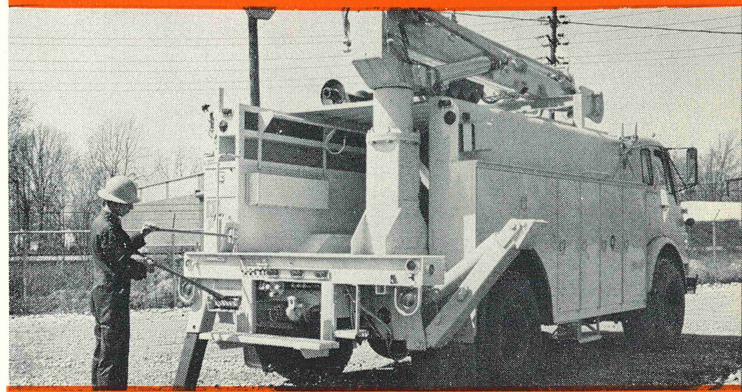
Early in 1968, delivery began on the first 32 new universal line trucks. Several safety features were recommended and included by the manufacturer to further increase convenience and versatility of the units. A 29-inch long, grab handle on each side at rear assures safe entry and exit to and from the body for all personnel. Stirrup steps and grab handles were included for convenient pike-pole removal. A 32-inch grip strut assembly at floor level in the rear doubles as a tailgate when in transit. All controls for the hydraulic equipment are located at the rear of the truck and must be operated with 36-inch fiberglass handles to assure isolation from the vehicle body and chassis.

Now, what have we gained through the extensive program to develop a new universal line truck? Standardization represents one important improvement. All line trucks use the same pump, PTO, doors, hardware, winch, and other equipment. Test procedures are standard; repair and maintenance is simplified.

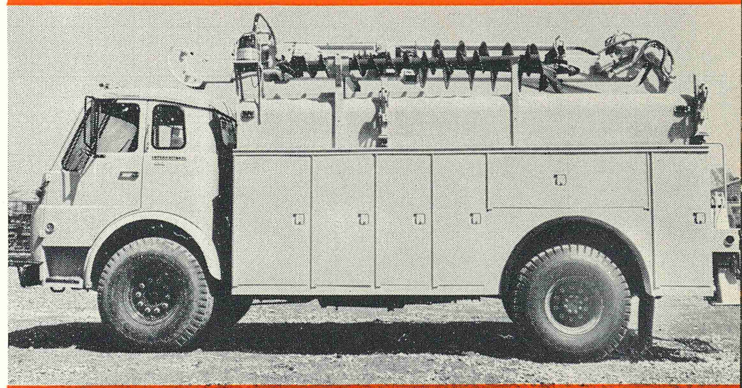
With the flexibility of modular construction in the line body, we can achieve a special body for particular crews without the expense of "special" work. To add a crew compartment, we remove one right-hand compartment. We can shift the winch compartment in any of three locations.

Most important, we've licked our axle-weight problem with the new line truck. Our crews now have a compatible line truck no matter what job they're performing. The new unit maneuvers easily in city streets and alleys, offers flexible design to meet crew needs, has the winch capacity to get the job done, and is equipped for maximum utility in use. The IHC Model VCO 190 tilt-cab carrying vehicle provides the space for a four-man crew, plus room for equipment storage in the rear of the cab. The Holan Mustang 72 derrick gives us 9,000 pounds of lifting strength, a 32-foot sheave height with fiberglass or steel extension booms available for extra reach to 40 feet, and digging torque capacity of 7,000 pounds-foot. We now have a 27,000-pound GVW line truck that's versatile, flexible, capable, and well within our axle loading requirements.

**Shifting** compartments for rubber goods, winch and various hardware forward helped redistribute weight to front axle.

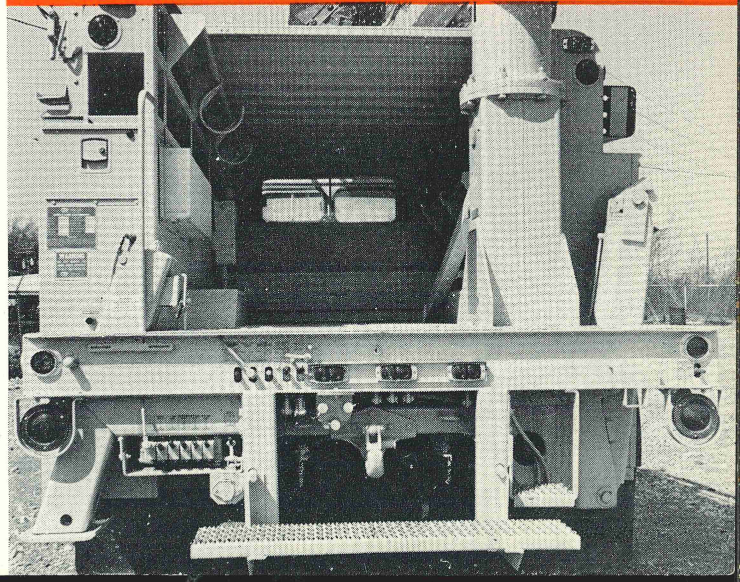


**Operation** of the line truck's equipment is achieved with 36-inch fiberglass handles. Note that jack location has been moved substantially forward.



**Modular construction** of the new body permits removal or exchange of compartments to meet specific-crew needs.

**Safety features** recommended and included on the new Holan Mustang 72 derrick include the 29-inch long grab handle, drop-down ladder bracket, and the 32-inch grip strut assembly.



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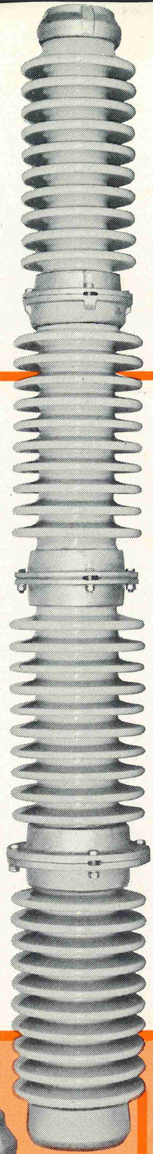
7912-H

# Economical tapered post stack retains electrical characteristics of uniform stack



## Many combinations available

*Proper assembly of the four units individually described produces this 1300-kV BIL tapered post with electrical characteristics and cantilever strength identical to extra-high-strength uniform-diameter stacking post. Rain shields are omitted to show flange details.*

Tapered insulator stacks are produced by combining O-B's solid-core porcelain post units of different strengths in the proper sequence to obtain a completed stack with electrical characteristics identical to those of a uniform-diameter stack of the same height, and with a cantilever strength rating matched to the specifications of the application.

The substantial savings in cost and weight of the tapered insulator stack, as compared to one of uniform diameter and strength, becomes an important factor at 900-kV BIL and increases rapidly at higher voltages.

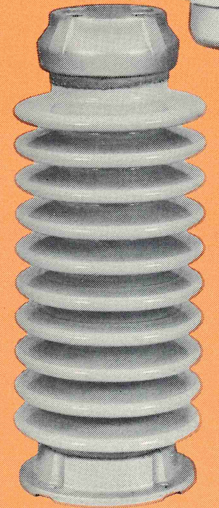
Design principles of the tapered stack can be demonstrated by describing the four individual post units which are assembled into one of the most widely used insulators for substation construction. A typical stack (O-B Number 47862) is a four-high, 1300-kV BIL tapered stack with a cantilever strength of 2050 pounds – equal to that of a four-high, 1300-kV BIL uniform-diameter stack rated as an extra-high-strength assembly.

In contrast to the corresponding uniform-diameter stack, each of the four post units in this tapered stack has a different strength rating. The unit at the bottom is a uniform extra-high-strength post; next above it is a transitional extra-high to high-strength post; above it another transitional unit, high- to standard-strength; and at the top a uniform standard-strength post.

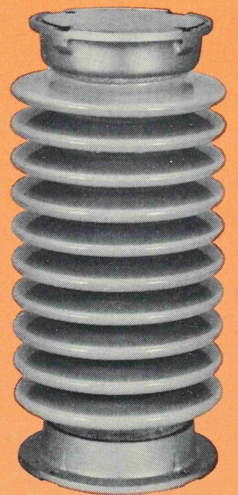
Transitional units incorporate a modification to accomplish a change in cantilever strength rating. In O-B transitional posts, this is achieved by orientation of the upper and lower flanges. In an upright stack, the transition from extra-high strength to high strength is made by fitting the upper end of an extra-high-strength post body with a 10⅜-inch bolt circle flange which will then mate with the lower flange of a high-strength post unit. Similarly, the transition from high strength to standard strength is made by fitting the upper end of a high-strength post body with a nine-inch bolt circle flange which will mate with the lower flange of a standard-strength post unit.

Tapered stacks for inverted mounting require a complete reversal of specifications for transitional post units, since the stronger units must be at the top and the weaker units at the bottom. Tapered stacks can be obtained with either a one-step or two-step reduction in strength ratings of the assembled post units.

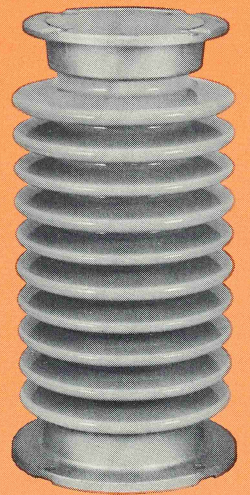
Many combinations of post units can be assembled into tapered stacks three, four, five and six units high to meet utility requirements. O-B's Catalog 67 illustrates and describes many of these options in stacks rated from 900- to 2050-kV BIL.



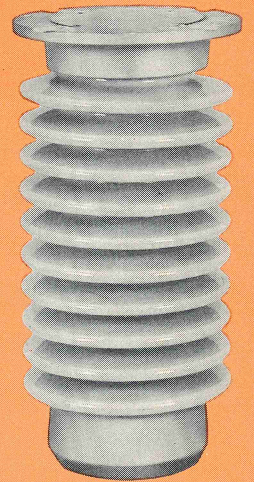
*Top unit is a 27-inch standard-strength post with 10 petticoats 11.5 inches in diameter. Top bolt circle is five inches in diameter; bottom bolt circle is nine inches.*



*Second unit from top is 26-inch standard- to high-strength transition post with 10 petticoats 12.5 inches in diameter. Upper flange is drilled and tapped for four ½-inch-13 capscrews equally spaced on a nine-inch bolt circle; bottom bolt circle is 10⅜ inches.*



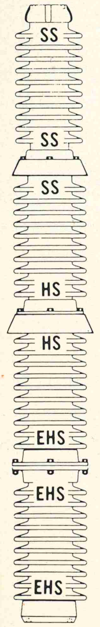
*Third unit down is a 26-inch high- to extra-high-strength transition post with 10 petticoats 12.5 inches in diameter. Bolt circle of upper flange is 10⅜ inches in diameter; bottom flange has 12-inch bolt circle.*



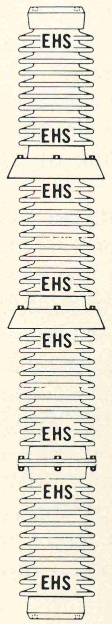
*Bottom unit is a 27-inch extra-high-strength post with 10 petticoats 12.5 inches in diameter. Upper flange has 12-inch diameter bolt circle; lower cap has seven-inch bolt circle.*



**COMPARISON OF CORRESPONDING TAPERED AND UNIFORM-DIAMETER STACKS**




| O-B Number 47862 (TR-369) Upright Tapered EHS Stack | M & E Values | O-B Number 47851 (TR-368) Uniform-Diameter EHS Stack |
|---|---|---|
| 106 in. | Height | 106 in. |
| 231 in. | Leakage Distance | 231 in. |
| 1410 kV | Impulse Critical (positive) | 1410 kV |
| 1300 kV | Impulse Withstand | 1300 kV |
| 525 kV | 60-Hz Withstand, 60 Sec. Wet | 525 kV |
| 220 kV rms | RIV, Test Voltage | 220 kV rms |
| 1000 $\mu$V | Max. RIV @ 1000 kHz | 1000 $\mu$V |
| 2050 lb. | Cantilever | 2050 lb. |
| 20 000 lb. | Tension | 40 000 lb. |
| 60 000 in.-lb. | Torsion | 120 000 in.-lb. |
| 60 000 lb. | Compression | 120 000 lb. |
| 720 lb. | Weight | 800 lb. |



# O-B's multipart pintypes resist contamination and vandalism

## Most are available with tietop or clamptop option

Millions of O-B multipart pintype insulators are in everyday service throughout the country, and every day proves the basic superiorities incorporated into their design and manufacture. Innovations in line construction in recent years have diminished the broad-scale application of multiparts, but no insulator has been introduced in its voltage classes which offers greater advantages.

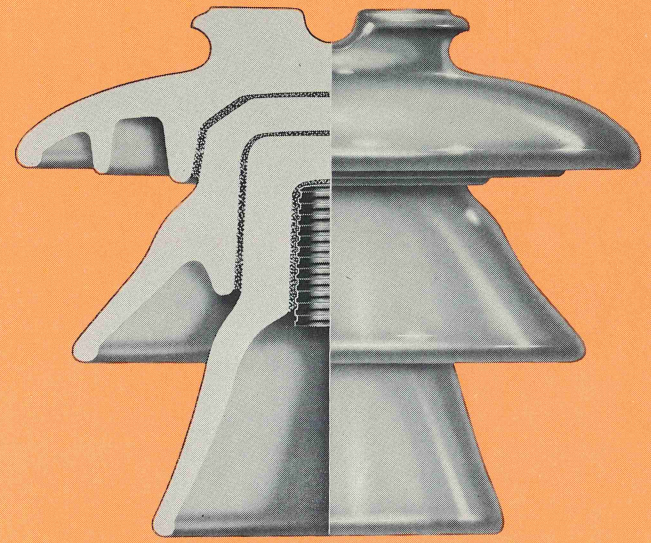
The deeply recessed contour of the multipart insulator is obtained by cementing two or more porcelain shells together in a concentric stack. This assembly achieves the primary objective of substantially increasing the insulator's effectiveness against airborne contamination.

O-B multipart pintypes have been investigated under steep-wave lightning impulse discharge and designed with higher dielectric strength than the surrounding air path under realistic lightning conditions. Thus, voltage overstress in multipart insulators is invariably relieved by harmless external flashover rather than by fatal puncture.

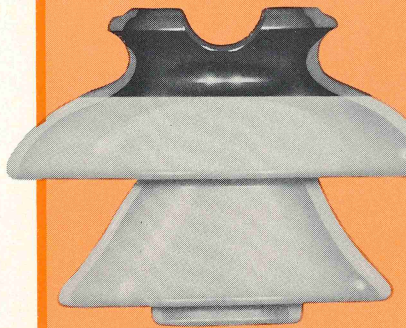
The multiple dielectric shells offer greater protection from vandalism. Break the major skirt and head section of a multipart with a rifle bullet or a lucky shot with a rock, and the insulator isn't destroyed. One or two inner head sections and secondary skirts, in all probability, will remain intact and will keep the line in service until a change-out can be made.

O-B multipart insulators are available for 23-, 34.5-, 46- and 69-kV classes. All except the 23-kV rating and the severe-service, four-skirted 69-kV model can be furnished with either tietop or clamptop option. All have Silentype glaze which relieves electrical stress concentration and reduces RIV.

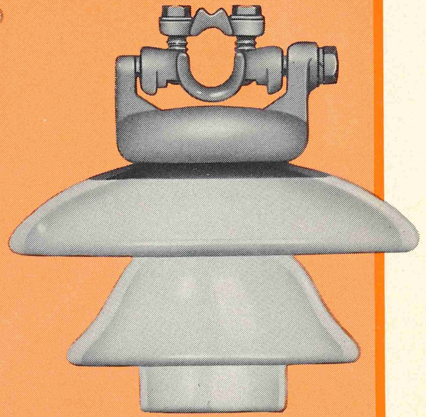
O-B manufactures a full line of both multipart pintype insulators and line posts. Each has certain advantages and there are some definite preferences in the electrical industry. The multipart pintype has an excellent operating record and continues to earn its place as a major factor in distribution and subtransmission construction.



*Section view of O-B multipart insulator illustrates the stacked assembly of three concentric porcelain shells which produces operating superiorities.*



*Darker color of the upper surface of typical 23-kV multipart insulator indicates Silentype glaze which reduces electrical stress concentrations.*

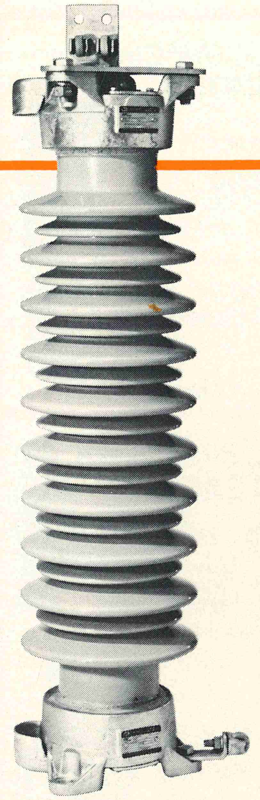


*Speed and simplicity of installation is a major advantage of the clamptop option available on O-B's multipart pintypes 34.5- through 69-kV ratings.*

*Tietop multipart pintype insulator for severe duty on 69-kV circuits. Extra leakage is obtained by the addition of a fourth skirt.*



# DynaVar added to complete listing of Ohio Brass surge arresters



*O-B's new DynaVar represents the latest advance in arrester performance and durability. Combining gap technology with metal oxide varistors, DynaVar opens a new era of arrester technology.*

## Selection based on maximum continuous operating voltage

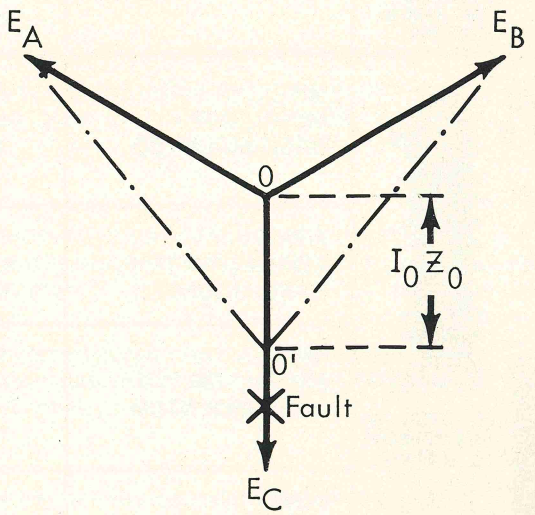
Ohio Brass supplies surge arresters in all three classes commonly used by electric utilities. These classes are designated by industry standards as distribution valve, intermediate valve and station valve. Many important variations exist in each class, related specifically to application requirements and voltage ratings.

Arrester selection for individual installations can be as simple as ordering distribution transformers with factory-mounted and connected arresters. At the other extreme, a computer study of EHV system transients is the recommended procedure for establishing the insulation levels which must be protected.

For the thousands of arrester applications which fall between these extremes, a sequence of logical steps can be followed to obtain an engineering basis for arrester selection.

1. Determine arrester voltage rating.
2. Estimate arrester discharge current and wave shape based upon line insulation level and surge impedance. (Refer to ANSI Standard C62.2-1969.)
3. Estimate insulation level to be protected.
4. Compare arrester classes: distribution, intermediate, station.
5. Prepare insulation coordination diagram. (See O-B Publication 2372-H.)
6. Confirm arrester voltage rating and class.

*Arrester application engineers have traditionally selected an arrester voltage rating at least equal to the highest phase-to-ground voltage that will ever occur on unfaulted phases during a phase-to-ground fault.*



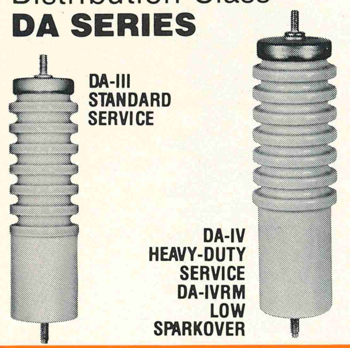
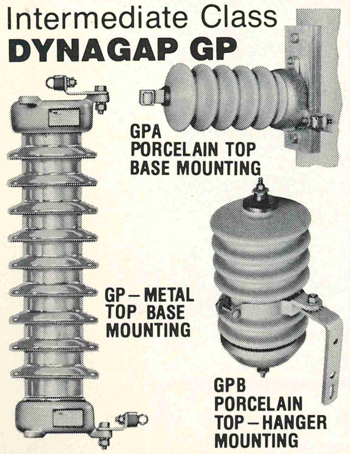
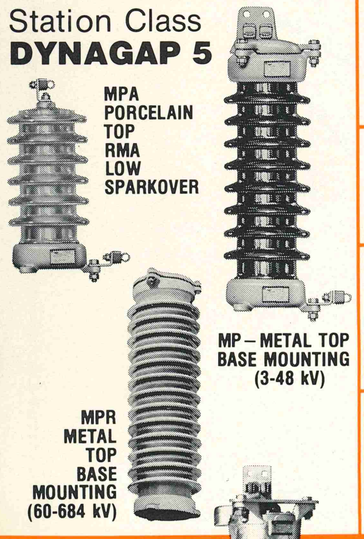
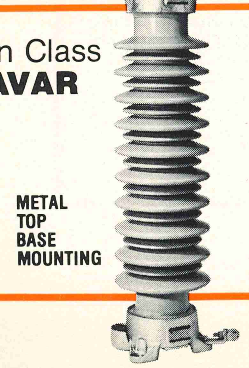

To obtain the maximum phase-to-ground voltage on unfaulted phases during a phase-to-ground fault, multiply the maximum system phase-to-phase operating voltage by the coefficient of grounding at the point of installation of the arrester. (Coefficient of grounding can be estimated from curves in "Guide for Application of Valve-Type Lightning Arresters for Alternating-Current Systems" ANSI C62.2-1969.)

Arrester Voltage Rating $\geqq E_{A\text{-}O'}$ or $E_{B\text{-}O'}$

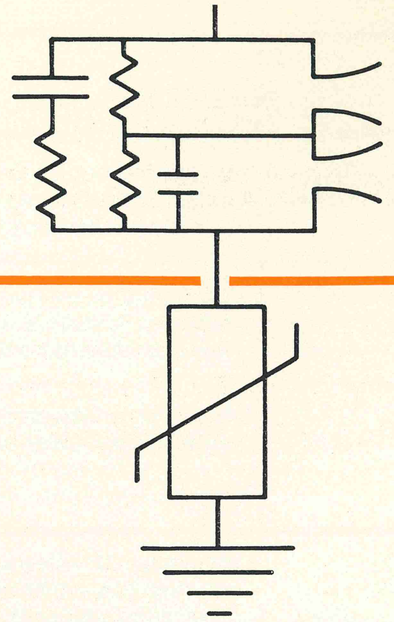
$\geqq (E_{A\text{-}B})\ (K_g)$

where $K_g$ is coefficient of grounding.

# Complete Listing of Ohio Brass Surge Arresters

| INDUSTRY CLASSIFICATION | TYPE | APPLICATION | VOLTAGE RATINGS | FEATURES | PUBLICATION REFERENCE |
|---|---|---|---|---|---|
| Distribution Class **DA SERIES**  | DA-III STANDARD DUTY | Suitable for all conventional distribution arrester applications. Widely used for distribution transformer protection in either pole- or transformer tank-mounted installations. | 3, 6, 9/10, 12, 15, 18 and 21 kV | Broad variety of low-cost optional attachments facilitate installation on poles, crossarms or transformer tanks. Accessories available for either externally gapped or ground lead isolator operation. | CATALOG 74, PUBLICATION 2470-H |
| | DA-IV HEAVY DUTY | Designed and built for any application for which distribution arresters are contemplated. Has durability characteristics consistent with expanding use of distribution arresters for line protection. | 3, 6, 9, 10, 12, 15, 18, 21, 27, 30 and 36 kV | Durability characteristics are more than double those of standard-duty distribution arresters. Uses same optional attachments as DA-III arresters for low-cost installations. High-voltage models include ratings of 27, 30 and 36 kV. | CATALOG 74, PUBLICATION 2627-H |
| | DA-IVRM LOW-SPARKOVER | O-B's high-durability distribution arrester specially adapted for low-sparkover operation gives improved surge protection for dry-insulated transformers and rotating machinery. Increases protective margins on dip pole installations of parallel arresters. | 3, 4.5, 6, 7.5, 9, 10 and 12 kV | Heavy-duty service distribution arrester with graded gaps to obtain lower impulse sparkover on installations where protective margins are critical. | CATALOG 74, PUBLICATION 2643-H |
| Intermediate Class **DYNAGAP GP**  | GP METAL TOP BASE-MOUNTED | Principal applications are in substations and load centers up to 138 kV. Dynagap GP intermediate arresters provide surge protection approaching that of station arresters at much lower cost. | Single unit: 3 thru 36 kV<br>Two-unit stack: 39 thru 72 kV<br>Three-unit stack: 78 thru 108 kV<br>Four-unit stack: 120 kV | Dynagap GP intermediate arresters are built with O-B's patented current-limiting gap construction in porcelain housings with identical top and bottom metal end caps. Can be mounted vertically, horizontally or suspended. Units can be stacked for higher kV ratings. All GP arresters have full facilities for pressure-sensitive pressure relief. | CATALOG 48C, PUBLICATION 2475-H |
| | GPA PORCELAIN TOP BASE-MOUNTED | Most popular of all O-B arresters for dip pole protection. Can be mounted vertically or horizontally. Special brackets available to position GPA arresters for shortest possible leads and improved appearance of poletop equipment. Reduced clearance of porcelain-top design allows use within metal-clad switchgear up to 34.5-kV ratings. | 3, 4.5, 6, 7.5, 9, 10, 12, 15, 18, 21, 24 and 30 kV | Current-limiting gap intermediate arresters provide ample protective margins for underground cable installations 23 kV and below. Porcelain-top line connection reduces required clearance between arresters. All GPA arresters have two-stage pressure relief. | CATALOG 48C, PUBLICATION 2573-H |
| | GPB PORCELAIN TOP HANGER-MOUNTED | Current-limiting gap GPB arrester specifically designed for low-cost pole mounting. Has clamping-band support for attachment to NEMA angle or crossarm brackets. Saves installation time and produces clean, attractive arrangement of poletop equipment. | 9, 10, 12 and 18 kV | Provides ample protective margins on cable riser pole installations. Clamping-band support permits use of ground lead isolator in addition to built-in pressure-actuated pressure relief facilities. | CATALOG 48C, PUBLICATION 2573-H |
| Station Class **DYNAGAP 5**  | MP METAL TOP BASE-MOUNTED | Dynagap 5 advanced-design current-limiting gap arrester in single-column construction for low- and medium-voltage high-reliability substations. | Single unit: 3 thru 39 kV<br>Two-unit stack: 45 and 48 kV | MP arresters are O-B's premium-grade station class design incorporating second-generation current-limiting gaps for the most effective surge protection available. All units have O-B's efficient pressure-sensitive pressure relief. | CATALOG 47E, PUBLICATION 2475-H |
| | MPA PORCELAIN TOP BASE-MOUNTED | Premium-grade station arrester with porcelain-top housing for installations where clearances between arresters or adjoining equipment are limited. | 3, 4.5, 6, 7.5, 9, 12 and 15 kV | MPA porcelain-top station class arresters have identical internal construction as single-column Dynagap MP and the same pressure-sensitive pressure relief mechanism in their base castings. | CATALOG 47E, PUBLICATION 2475-H |
| | MPR METAL TOP BASE-MOUNTED | MPR Dynagap 5 station arresters provide the most comprehensive and effective surge protection available for transmission systems of all voltages, including the highest contemplated. MPR arresters are successfully adapted to both $SF_6$ and HVDC systems. | 60 thru 684 kV | Outstanding performance in all categories of surge arrester protection with O-B's second-generation current-limiting gap. Excellent overvoltage interrupting capabilities. Safest and most effective pressure relief system. | CATALOG 47E, PUBLICATION 2136-H |
| | RMA PORCELAIN TOP BASE-MOUNTED | RMA arresters combine the premium-grade operating characteristics of the Dynagap 5 station arrester with special low-sparkover provisions for optimum protection of rotating machinery and dry-insulated transformers. Normally installed in conjunction with wave-sloping capacitors. | 3, 4.5, 6, 7.5, 9, 12 and 15 kV | Has all features of Dynagap 5 advanced station class current-limiting gap design arresters, efficient pressure relief, and reduced clearance requirements of porcelain-top arresters. | CATALOG 47E |
| Station Class **DYNAVAR**  | METAL TOP BASE-MOUNTED | DynaVar arresters provide increased station protection for transmission systems. In normal applications DynaVar has substantial overvoltage withstand capability of 1.5 times MCOV for 100 seconds or 1.4 times MCOV for many hours. On delta systems, advantage can be taken of the 140 percent of MCOV capability. | 42 thru 254 kV (for system voltages 69 kV to 400 kV) | DynaVar metal-oxide arresters combine a heavy-duty gap paralleling linear capacitance and resistance, in conjunction with an extremely nonlinear metal-oxide varistor valve element for high energy dissipation and overvoltage capability in a lightweight unit of compact size. | PUBLICATION 2701-H |

# DynaVar arresters
**(continued)**



**Conventional arresters:** The minimum arrester voltage rating must exceed the maximum expected line-to-ground power frequency voltage at the proposed arrester location. Arrester ratings are traditionally obtained by selecting a rating at least equal to the highest phase-to-ground voltage which will ever occur on unfaulted phases during a phase-to-ground fault. Arrester voltage ratings for EHV systems can be determined from results of transient analyzer studies, but are often modified to reflect the advance capabilities of modern current-limiting gap arresters such as O-B's Dynagap 5.

**DynaVar metal-oxide surge arresters:** DynaVar is a totally new design incorporating a heavy-duty gap paralleling a linear impedance of capacitance and resistance elements, in conjunction with an extremely nonlinear metal-oxide varistor valve element. At normal operating voltage, approximately 20 percent of the total arrester applied voltage appears across the series impedance and the remaining 80 percent across the metal-oxide valve element. Since the valve element carries a substantial part of the normal operating voltage, and conducts a continuous small grading current, the most important application criterion for this arrester is the maximum voltage which can be continuously applied to it. Ohio Brass describes DynaVar by its maximum continuous operating voltage or MCOV. The selection of the proper arrester is simplified.

To apply DynaVar, for example, a nominal 138-kV system usually has a maximum line-to-line continuous voltage of 145-kV rms. 145-kV divided by $\sqrt{3}$ gives 84-kV rms line-to-ground voltage. The appropriate DynaVar arrester for this application is the DynaVar 84. The nameplate of this arrester reads: "maximum continuous operating voltage $145/\sqrt{3} =$ 84-kV rms".

The DynaVar arrester in normal application has substantial overvoltage withstand capability of 1.5 times its MCOV for 100 seconds or 1.4 times its MCOV for many hours. For conventional grounded neutral systems on which a fault is expected to initiate a circuit breaker operation within a few cycles, the DynaVar arrester with MCOV equal to maximum line-to-neutral voltage is suitable, regardless of grounding coefficient at the arrester location. For ungrounded neutral or delta systems, advantage can be taken of the overvoltage capability of DynaVar. For example: If a ground fault on one phase is expected to be removed promptly by system relaying, the recommended normal-duty MCOV for the ungrounded system becomes maximum line-to-line voltage divided by 1.4.

*DynaVar's design incorporates a heavy-duty gap paralleling a linear impedance of capacitance and resistance elements in conjunction with an extremely nonlinear metal-oxide varistor valve element.*

Estimating the insulation level to be protected can be one of the more difficult preliminary qualifications. The "when new" impulse and chopped wave strength of practically all equipment is affected by age, overload history, physical conditions and electrical connections. Even a small loss in insulation strength will reduce protective margins.

Selection of arrester class – distribution, intermediate or station – necessitates a comparison of arrester protective and durability characteristics as well as consideration of the features which are available in each class. Factors influencing the decision are the importance of the protected equipment, the cost of a possible service outage, the short circuit current available at an arrester location relative to pressure relief facilities in the event of an arrester failure, connected equipment such as capacitor banks, cables or EHV lines, altitude of installation and maintenance.

After the decision has been made on the arrester class and voltage rating, a number of major options are offered which simplify or improve the installation. These options are tabulated on the preceding pages.



# Hi*Lite insulators save money on construction projects

## Field experience must be factored-in to arrive at a realistic cost

Several utilities and contractors have volunteered the comment that O-B is missing an opportunity by not outlining some of the unanticipated savings in building a line with Hi*Lite suspension insulators. These savings take place on the construction job – not in the front office – but they are the same dollars, and often sizable. We suggest you have a pad of paper handy to jot down some figures as you go. We can supply only the formula. Some of the answers must be based on your own experience.

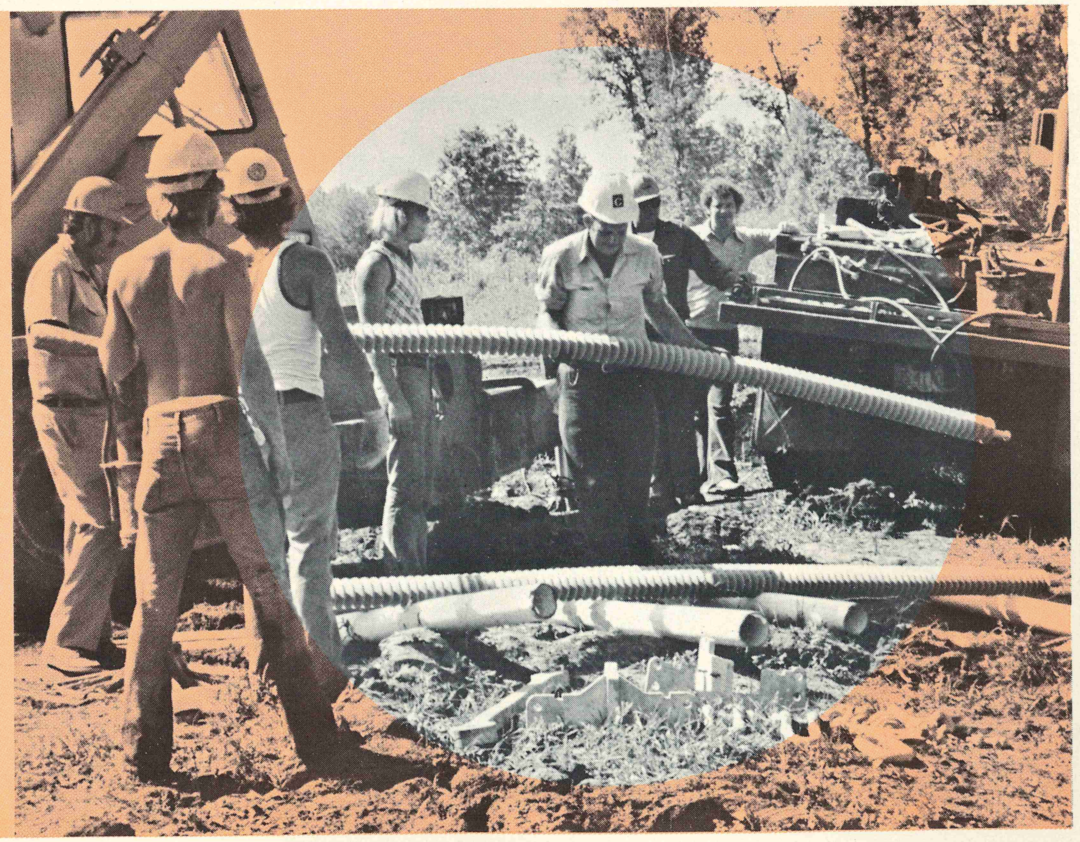
Economies stem from the lightweight, small-volume, one-piece construction, and virtual immunity from breakage, typical of Hi*Lite insulators. We will assign some concrete values to these.

To remain consistent we will, in all cases, assume a 500-kV line built on steel towers, using single strings of insulators in V configuration in tangent, and two yoked strings in deadends. Porcelain insulators for this purpose would be O-B Number 47610 with an M&E rating of 40 000 pounds. Hi*Lite insulators would be Number 232027 with a maximum design tension of 20 000 pounds. These two strength ratings are equivalent since porcelain is worked at, or below, half M&E value, whereas Hi*Lite may be worked up to its published maximum design tension. Where porcelain is used, 25 units per string are required. The two insulating systems are electrically comparable.

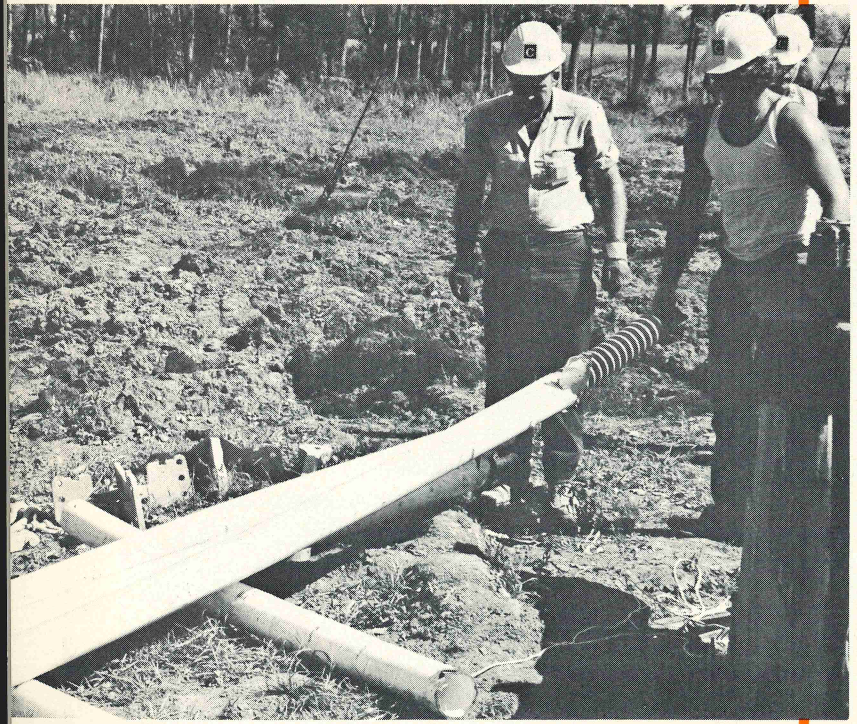
**TANGENT TOWER**

In this case, six strings of insulators are required in the three phases for the V conductor supports.

*Hi*Lite's lightweight, one-piece construction and virtual immunity from breakage yield real savings that become apparent at the construction site.*



*Unpacking a Hi*Lite insulator for a 500-kV line. The complete one-piece insulator has a weight of less than 50 pounds. Its porcelain equivalent would weigh 465 pounds and come in five separate shipping crates weighing 93 pounds each.*



Porcelain will involve 30 crates weighing 93 pounds each, totaling 2790 pounds. Such a load must be transported to each tower. The truck must be loaded by hand labor at the storage area (30 crates, 93 pounds each), driven to the construction site, and unloaded in the same way. Sixty man-lifts of 93 pounds each are required on and off for each tower. As a day-long job, this will probably call for two men on the truck and two on the ground. Assign your own figures to the number and cost of man-hours you would apply to this work, plus charges for the truck and driver to make a round trip between the line and storage area.

| Handling porcelain insulators for one tangent tower |
|---|
| Charge for truck with capacity of 2800 pounds and 780 cubic feet |
| Cost of operating truck, round trip between storage area and tower |
| Driver's time, round trip between storage area and tower |
| Labor for 60 man-lifts of crates, 93 pounds each, on and off truck |

Good access may permit carrying two tower quantities in a single truckload (5580 pounds – 1560 cubic feet). Labor cost per tower would still be the same, but trucking cost per tower less.

Many variables will enter into the estimate you make, such as poor access and distance from storage to the construction site. In any case, you will produce a figure that, for years, has been taken for granted in building with porcelain insulators, and that has been accepted as a "necessary evil". Its amount may be a surprise. Compare it with Hi*Lite.

Six one-piece Hi*Lite suspension insulators are required. Each insulator is packed in a substantial tube 5 inches in diameter by 14½ feet long. Weight of the complete insulator is 50 pounds. The six pieces weigh 300 pounds. The same truck that can supply porcelain insulators for a single tower can deliver all the Hi*Lites for nine towers – approximately two miles of line.

Six man-lifts of only 50 pounds each will load the truck for one tower. Six more easy lifts unload it. Time spent is only a few minutes, often by only one man, since the tubes stack neatly parallel to the truck bed. Transportation of Hi*Lites, in this case, is nine times as efficient, and utilization of man-hours may be that or more.

| Handling Hi*Lite insulators for nine tangent towers |
|---|
| Charge for truck with capacity of 2700 pounds and 1215 cubic feet |
| Cost of operating truck, round trip between storage area and line |
| Driver's time, round trip between storage area and line |
| Labor for 108 man-lifts of easily handled tubes, 50 pounds each |

Then divide your total by nine because the above items cover nine towers.

Recall a few transportation jobs on your own system and apply these facts to them. The money per tower saved by Hi*Lites may astonish you, especially when you multiply the result by four or five towers per mile of line.

## HELICOPTER TRANSPORTATION

So far we have been talking only in terms of surface transportation. A contractor once commented that helicopters operate at another magnitude of cost. In this case both weight and volume are factors. Note the following tabulation.

| Insulators for one tangent tower | |
|---|---|
| **PORCELAIN** | **HI*LITE** |
| 30 crates,<br>93 pounds each<br>Weight 2790 pounds<br>Volume approximately<br>780 cubic feet | 6 tubes,<br>50 pounds each<br>Weight 300 pounds<br>Volume approximately<br>135 cubic feet |

Unproductive time is one of the biggest cost items in helicopter service – time spent on the ground loading and unloading – time spent deadheading back to the storage area due to limited cargo capacity. Efficient use of the craft can double or triple the return in terms of work accomplished opposed to the high hourly cost of operation.

Type of aircraft, terrain, distance, all insert some wide variances in the use of helicopters. The only common denominator is that they're not cheap! Most engineering departments have, or can obtain, costs of helicopter operation related to their own construction. It will be interesting to apply these figures to the facts presented in the preceding tabulation. The saving may be a major item in the cost of building a line.

## HANDLING INSULATORS

Going back to the business of loading and unloading 30 crates of porcelain weighing 93 pounds each, there is another factor present. These 93-pound packages are breakable. Porcelain insulators require considerable care in handling.

Hi*Lite insulators, on the other hand, are virtually immune to damage. Being lighter in weight there is less tendency to abuse them and, if this fact does not apply, they can withstand almost any kind of abuse that will be encountered.

Discovery of a damaged porcelain insulator calls for a replacement on the job that may involve delay in construction. Hi*Lite insulators prevent these "lost-time accidents".

Working with Hi*Lites on a line is greatly simplified by their one-piece, lightweight design. One contractor we interviewed commented that he built a two-way, 500-kV deadend in about half the time required for porcelain insulation (saving $3000 in the process). We have received a number of reports that contracting firms, experienced in the use of Hi*Lites, have offered discounts on their bids if these insulators are specified.

## STRUCTURE COSTS

Going back to the typical 500-kV line used as an example in this discussion, Hi*Lite insulators will save (in round numbers) 2500 pounds of dead weight on a tangent tower and 5000 pounds on a two-way deadend tower. In some types of steel fabrication, this saving will permit minor modification in material and bracing. While this saving may not be large, it is multiplied by the number of towers on a line, at which time it becomes a figure worth consideration.

## CONCLUSION

At the time the purchase of insulators is being negotiated, the true picture of cost of Hi*Lite construction cannot be evaluated from a price list. Feedback from many field sources must be factored-in before a realistic cost can be established. Careful investigation may materially favor choice of Hi*Lite insulators.

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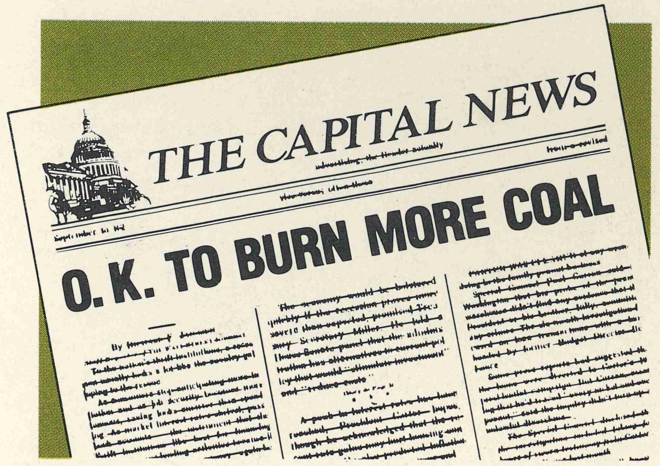
OHIO BRASS
MANAGEMENT
REPORT

# Good news depends on you and me

By Roger A. Black, *Chairman of the Board*
The Ohio Brass Company




How would you like to hear the evening news end like this?

"**ENVIRONMENTALISTS** and forces advocating greater use of coal have reached an important compromise. Federal regulators and Congressional spokesmen for environmental groups have agreed to relax regulations on mining and burning coal so that more coal can be used without endangering public health. In turn, mining and electric power companies will continue to do everything economically feasible to protect the environment."

**AT THE MOMENT** this "good news" is pure fiction. Despite priorities assigned to energy legislation, obstacles to burning coal still prevail. Can the good news become reality? The former secretary of the Department of Energy says it must become reality if our society is to survive in its present form.

**MAY I SHARE** two observations?

We must quit, for the moment, pursuing such will-o'-the-wisps as solar energy. Certainly, it offers some promise. But our need for more energy is now. Synthetic fuels, oil from shale, geothermal and all the rest have their place. But they don't provide the volume of energy that we need now. Let's get going on coal and then worry about other ways to get energy.

**MY SECOND OBSERVATION** is that we don't argue very effectively in favor of coal, at least not in public debate. We all recognize merit in the environmentalist cause. Consequently, our response to the extreme environmentalist arguments is often half-hearted or there is no response at all. Or haven't you heard this remark, "The answer is too technical for the public to understand."

**OUR TRADE ASSOCIATIONS** may testify effectively before Congressional committees but the battle is fought in the public forums and media where the public listens and the votes are generated.

**EVERYONE THAT BELIEVES** in coal as the principal answer to the energy crisis should be ready to speak formally on three points:

1) Coal mining's safety record is improving steadily.
2) Under proper conditions, burning of coal will not harm the environment. The polar ice cap is safe.
3) The earth is restored to usable condition after coal is mined, often in better condition than it was before.

**WE ARE COMPLETELY RIGHT** in our advocacy of coal. Coal is the only real answer. But much of the public does not perceive us as right. Unless we change public opinion, our society will not continue to grow. If we want good news, we must make it happen.

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8001-H

# Hi-Tension News

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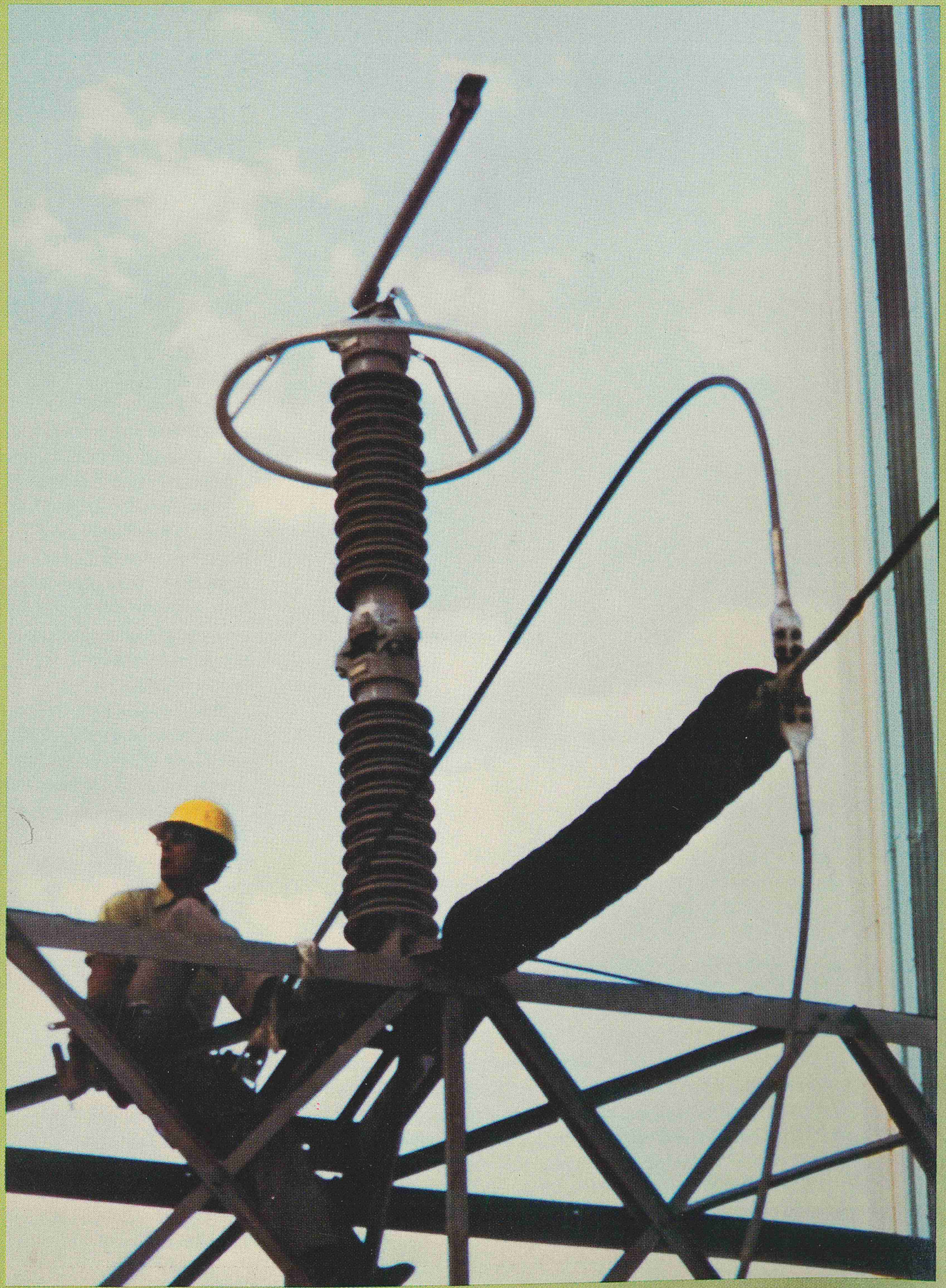
Good news depends on you and me. Ohio Brass management report back cover

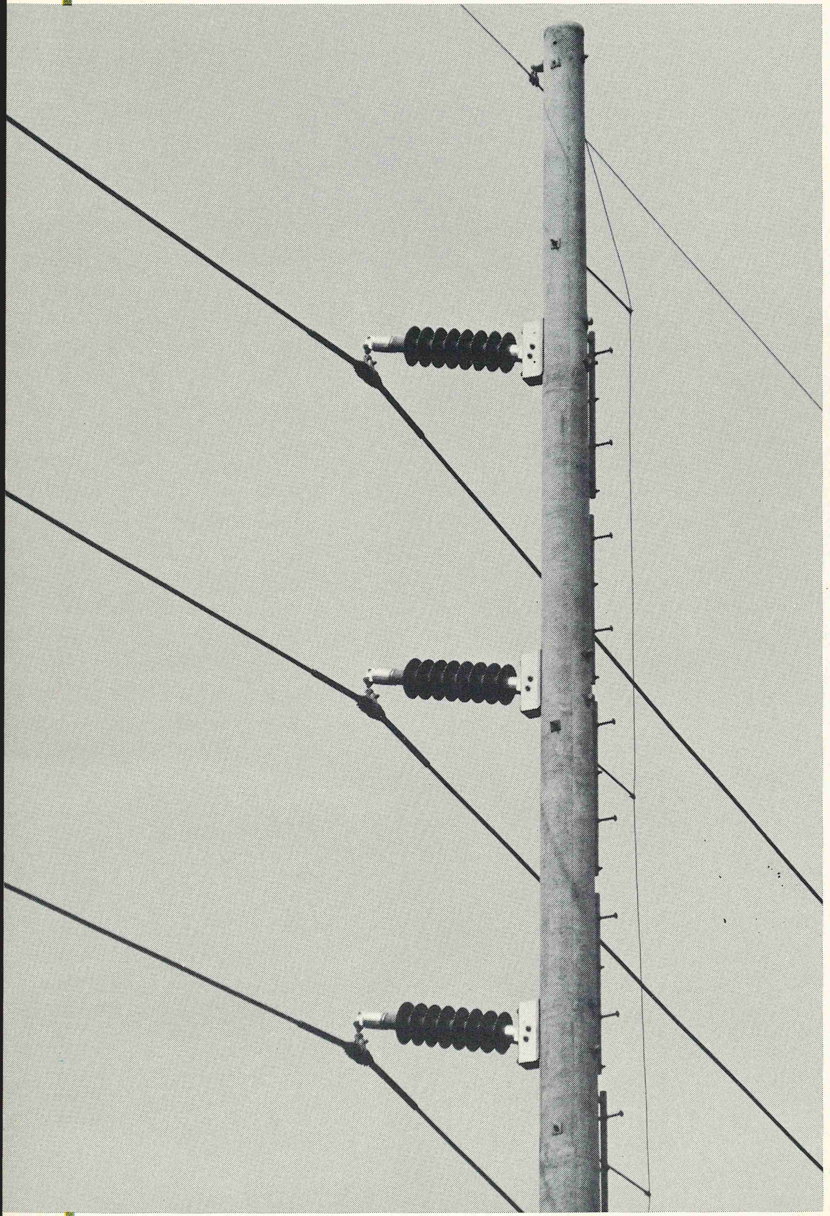
THE COVER PHOTO

Southwestern Public Service Company installs DynaVar for transformer protection at its Clifford B. Jones Station, Lubbock, Texas



# Hi*Lite® insulators aid in building 138-kV line on existing right-of-way

## Line also benefits from high electrical and mechanical reliability and improved appearance



*The application of Hi*Lite insulators mounted on concrete poles was chosen as the best means of utilizing the existing right-of-way in building part of a 138-kV interconnection between the Springfield City Water, Light and Power Department and Illinois Power Company. Series 350 horizontal posts offered the strength and resilience needed to accommodate the cantilever load resulting from a heavy conductor and 650-foot spans.*

Today more than ever, engineers responsible for designing transmission lines find themselves obliged by economics and public relations to investigate more effective ways of utilizing public access or an existing right-of-way. The dramatic increase in the time and costs involved in securing new easements is encouraging both the exploration of alternative materials for line construction and the application of new products designed to meet the electrical, mechanical and aesthetic demands at present confronting electric power transmission.

On more than one occasion, Hi*Lite insulators have provided part of the solution to a utility's right-of-way problem. Hi*Lite's efficient construction, combining high strength with light weight and a slender appearance, makes it a particularly appropriate insulator on lines designed to operate within minimum right-of-way requirements.

In a recent application, the Springfield (Illinois) City Water, Light and Power Department was able to avoid negotiating easements with individual property owners in order to rebuild a 69-kV tower line, converting it to a 138-kV interconnection with Illinois Power Company. Use of Hi*Lites – both horizontal line posts and suspension insulators mounted on concrete poles – allowed the line to be reconstructed with a heavier conductor while accommodating existing right-of-way restrictions. The combination of Hi*Lites and concrete poles also effected a marked improvement in the line's appearance.

The first eight miles of the interconnection, extending from a substation east of Springfield through the city of Riverton, were constructed on concrete poles. The rest of the line continues 12 miles to the Illinois Power tie-in at Illiapolis. The interconnection provides for wholesale power exchanges between the two utilities and assures a temporary power backup for a chemical plant near Illiapolis.

*The 34.5-kV circuit on the left, which belongs to Central Illinois Light Company, joins the Springfield City Water, Light and Power line just outside Springfield. Both circuits are built to 138-kV specifications and share the right-of-way and poles through Riverton, reducing the visual impact and costs that would have been involved in building two separate lines. Hi*Lite suspension insulators mounted on davit arms are used to widen spacing between phases on each circuit.*

In rebuilding the line, a heavier conductor, 1272-cmil ACSR, was chosen to reduce power losses. The existing easements restricted tower placement to eight per mile (650-foot spans) in the rural areas and one per block (450-foot spans) through Riverton. Supporting structures capable of withstanding the strain imposed by the conductor weight and span length could be no larger than the lattice steel towers they replaced and still comply with the same right-of-way restrictions.

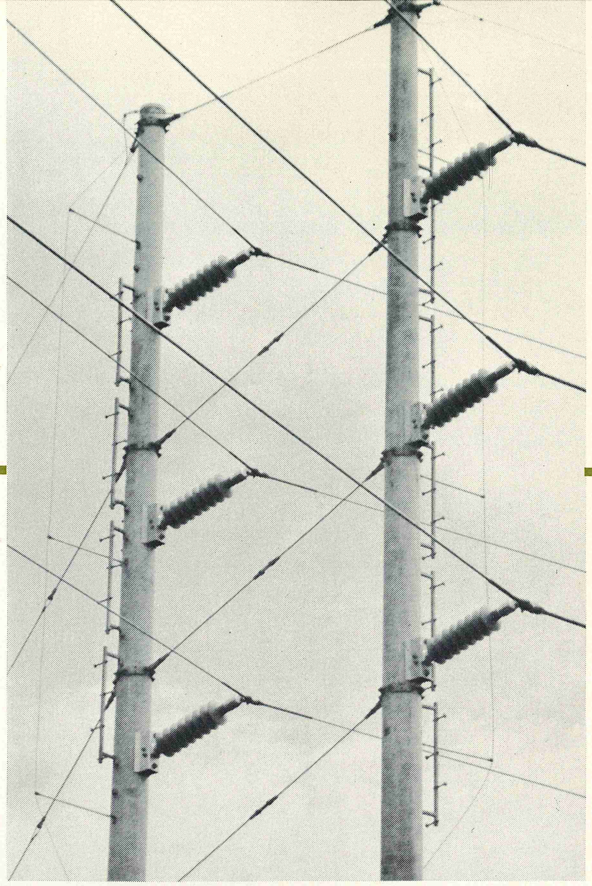
The application of Hi*Lite insulators mounted on concrete poles was chosen as the best means of utilizing the existing right-of-way. The round, hollow, prestressed poles are strong enough to permit the use of a heavier conductor in 650-foot spans. Poles are 85 to 125 feet long and weigh 8.5 to 16 tons each. Clean, straight and of uniform strength, concrete poles provide a reliable and attractive supporting member.

The strong, resilient Hi*Lite post insulator complements the strength of a rigid concrete pole. Because of its stiffness and high inertia due to its weight, the concrete pole remains practically unyielding to any mechnical shocks transmitted by the conductor, putting excess stress on the insulator acting as a junction between conductor and pole. In this application, a brittle porcelain post insulator is highly vulnerable to stresses encountered during severe shock loading. In contrast, Hi*Lite's fiberglass core allows it to first comply with the shock force and then return to its original state. The size of the conductor and spans on the Springfield-Riverton section, coupled with the severe wind and icing conditions frequently encountered in the area, were primary considerations in choosing the high working and reserve strength of Hi*Lite posts.

In crossing the open terrain between Springfield and Riverton, Hi*Lite suspension insulators mounted on davit arms are used instead of horizontal posts. A 34.5-kV line built to 138-kV specifications from Central Illinois Light Company joins the Springfield City Water, Light and Power line just east of Springfield, sharing right-of-way and poles into Riverton. While this arrangement reduces the visual impact and costs that would have been involved in building two separate lines, the double circuit is subject to high winds frequently encountered in the area, requiring increased clearances between phases. Use of 7.5- and 8.5-foot davit arms with suspension units increases phase-to-phase spacing sufficiently to allow for acceptable clearance even under windy conditions.

*continued on next page*

*For a 27-degree running corner in Riverton, Hi*Lite Series 350 horizontal posts provided a reliable and economical choice of insulation. The 4600-pound tension load imposed on the Hi*Lites would almost equal the ultimate strength of the comparable porcelain post insulator, leaving nothing as a safety factor. In this application, the Hi*Lites offer plenty of reserve strength while totally controlling phase-to-phase spacing. And they were found by the utility to be a more economical application than using suspension insulators in deadend construction.*

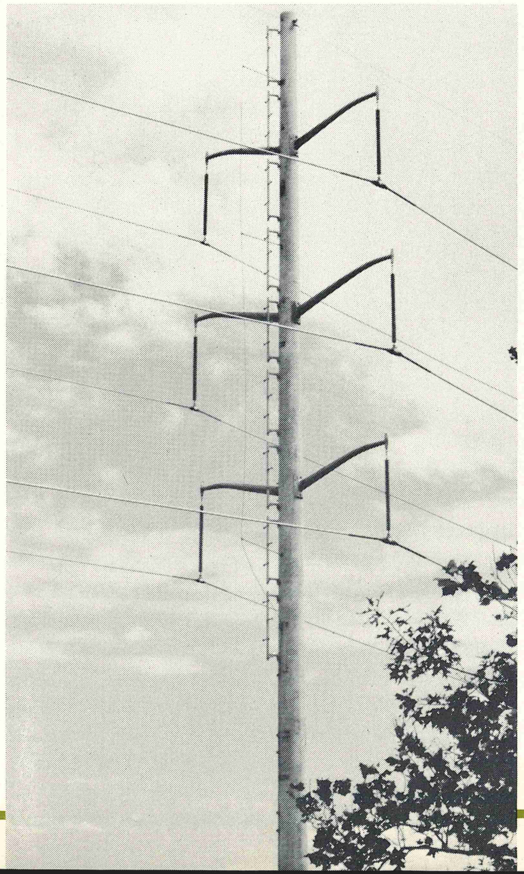


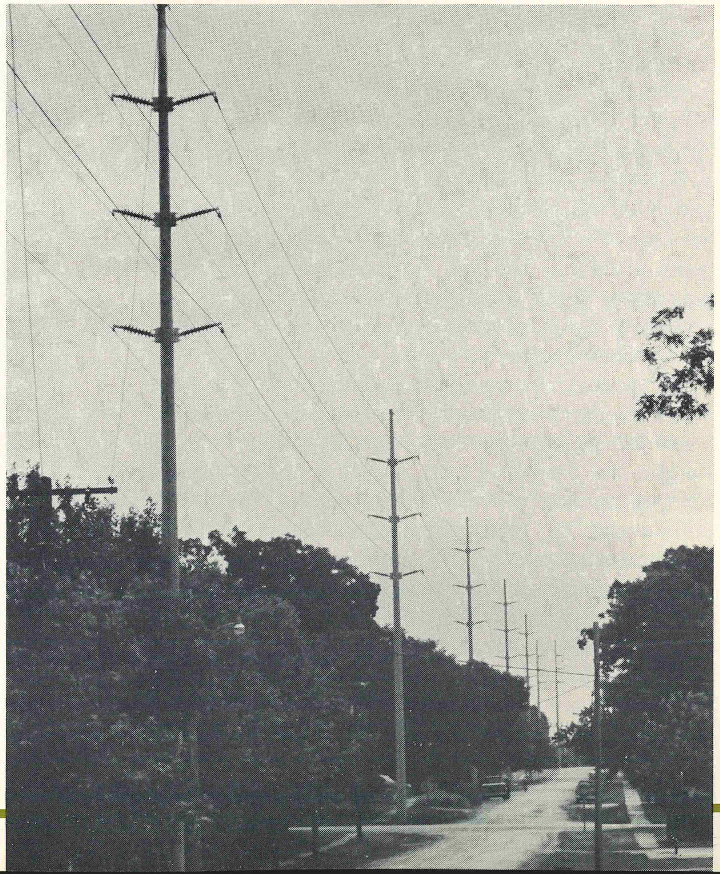
*continued from preceding page*

Both Hi*Lite suspension insulators and horizontal posts also work well with concrete poles for aesthetic reasons. Their strength accommodates the longer spans that can reduce line visibility. And Hi*Lite's neat, trim shape makes an important contribution to a line designed to be as pleasing and inconspicuous in appearance as possible.

The strength and inherent durability of Hi*Lite insulators provided the higher reliability factor necessary to reconstruct the Springfield-Riverton section with a heavier conductor according to existing easement restrictions. The combination of Hi*Lites and concrete poles produced a line that was improved in its electrical and mechanical reliability and in its appearance. And Hi*Lites and concrete poles proved to be an economical application, one that produced an improved line without the expense—and headache—of securing new right-of-way agreements.

*Rebuilding with Hi*Lites mounted on concrete poles improved the line's appearance. Hi*Lite's strength accommodates the longer spans that reduce line visibility and its neat, trim shape makes an important aesthetic contribution to a line that must traverse residential areas.*





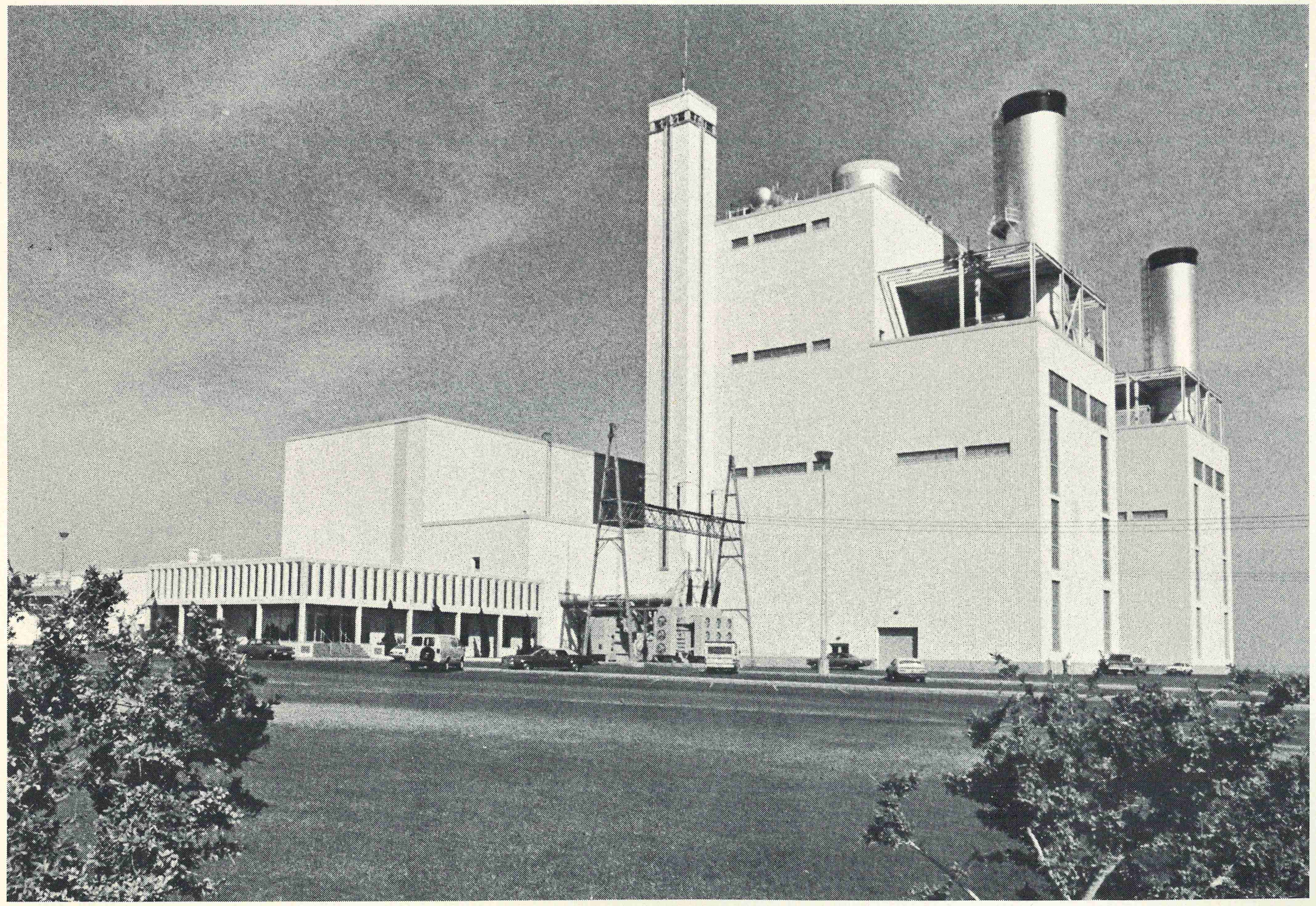


# Southwestern Public Service Company serves growth with innovation

## Installs DynaVar for station protection

Southwestern Public Service Company claims first honors for several innovations in the electric utility industry:

- First company to obtain exemption under the Public Utility Holding Company Act of 1935, when it became solely an operating utility in 1942.
- First automatic economic generation loading system in the United States.
- First utility to use digital and electronic analog turbine governors.
- Pioneer in the use of sewage effluent as cooling tower make-up water; and then, with further treatment, as boiler make-up water.
- First use of low-sulfur western coal in Texas.
- First use of bottom-dumping unit train fuel supply system in Texas.
- First installation of DynaVar, Ohio Brass Company's new surge arrester with metal-oxide varistors.



*DynaVar offers improved protective levels with a unit of reduced size and weight. The slim profile of three DynaVars protecting transformers at Jones Station does not detract from the gleaming appearance of the station.*

*Among SPS firsts is the installation of O-B's new DynaVar surge arresters with metal-oxide varistors for station protection.*

From its headquarters in Amarillo, Texas, Southwestern Public Service Company stretches north and south to serve a large section of Texas and portions of New Mexico, Oklahoma and Kansas. One-sixth of all irrigated land in the U.S. is in Southwestern Public Service Company's territory. Pumping during drought and air conditioning push up the company's summer peak load.

Steady growth enables the company to provide a regular return to its investors and, at the same time, to build new plants to serve a variety of customers. SPS works with local officials to attract new business to areas it serves. Population of its service area numbers over a million people, 250 000 of them customers.

Most transmission lines between Southwestern's power plants and major load centers are 230-kV.

Southwestern Public Service designs its facilities to fit its needs and, in doing so, has been an innovator in bringing new technologies to use in the industry. One example is the use of O-B's DynaVar for station protection in areas of heavy agriculture. DynaVar has outstanding capability to withstand the effects of severe external contamination, such as dust and agricultural fertilizer. DynaVar also offers improved durability and service reliability.

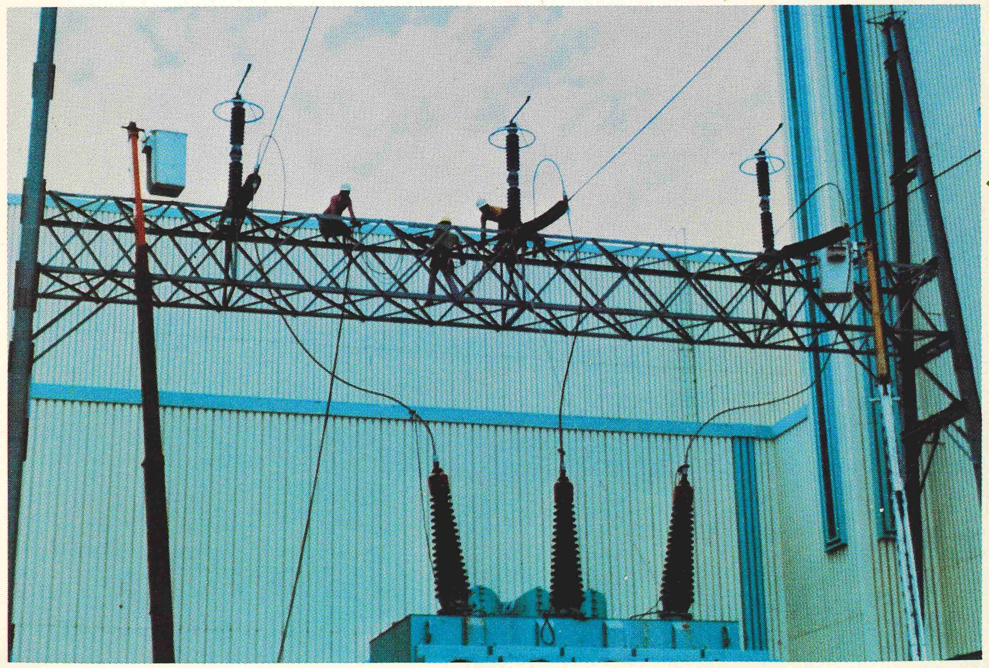
One of SPS's DynaVar installations is at Clifford B. Jones Station, Lubbock, Texas. Lubbock is the geographic and economic center of the Texas High Plains, a semi-arid region with average annual precipitation of 18 inches. Over 20 percent of the nation's cotton and 52 percent of the Texas cotton crop are grown in the 23 counties surrounding Lubbock. It's not surprising that Lubbock has earned the title of cottonseed oil capital of the world.

Water in any form is a valuable commodity in the Texas panhandle. Thus, all cooling tower water for the gas-fired Jones plant comes from spent sewage water. A water treatment plant at the site has the capability to bring effluent water up to boiler cleanliness levels.

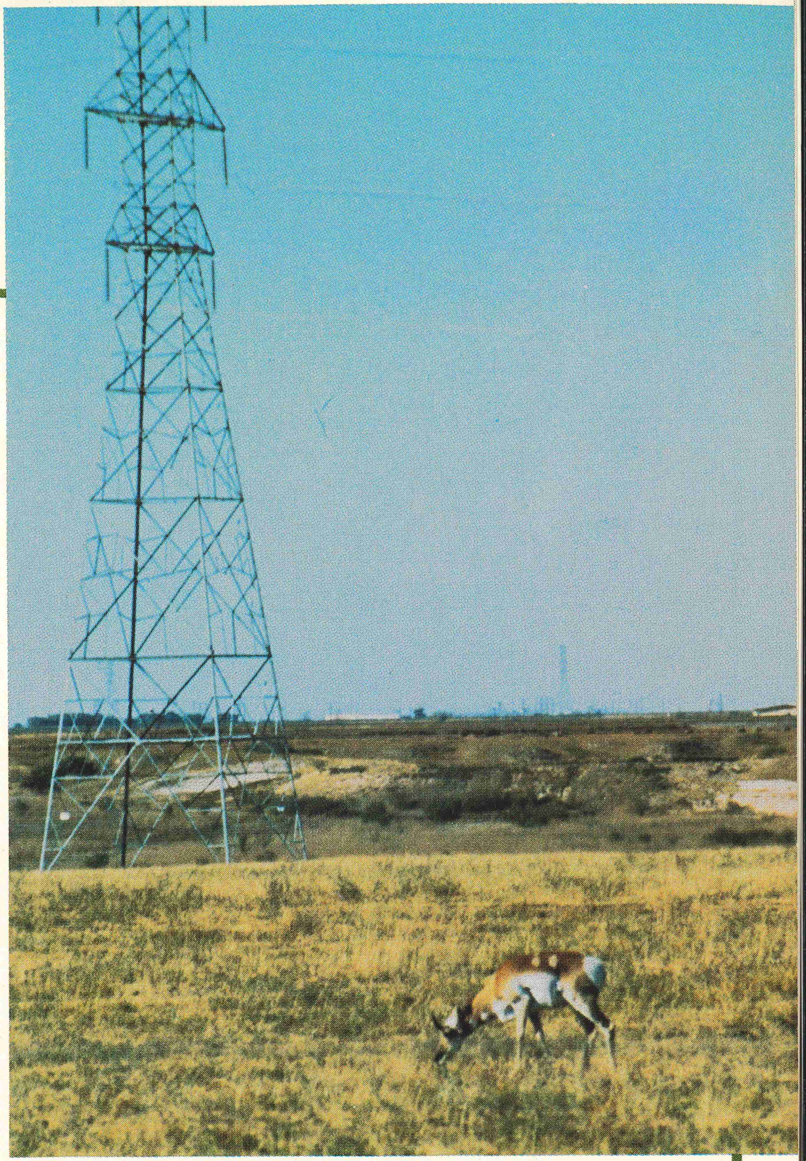
Southwestern Public Service was recently selected "Outstanding Electric Utility of the Year" by a leading electric utility publication because of its "strong financial performances in the face of a difficult fuel supply situation, its innovative efforts to solve the fuel problem and its success in bringing order to rapid growth in its service area."

When a dwindling natural gas supply became apparent in 1971, SPS selected coal as its primary fuel. By 1985, approximately 50 percent of SPS customers will be using electricity generated by coal.

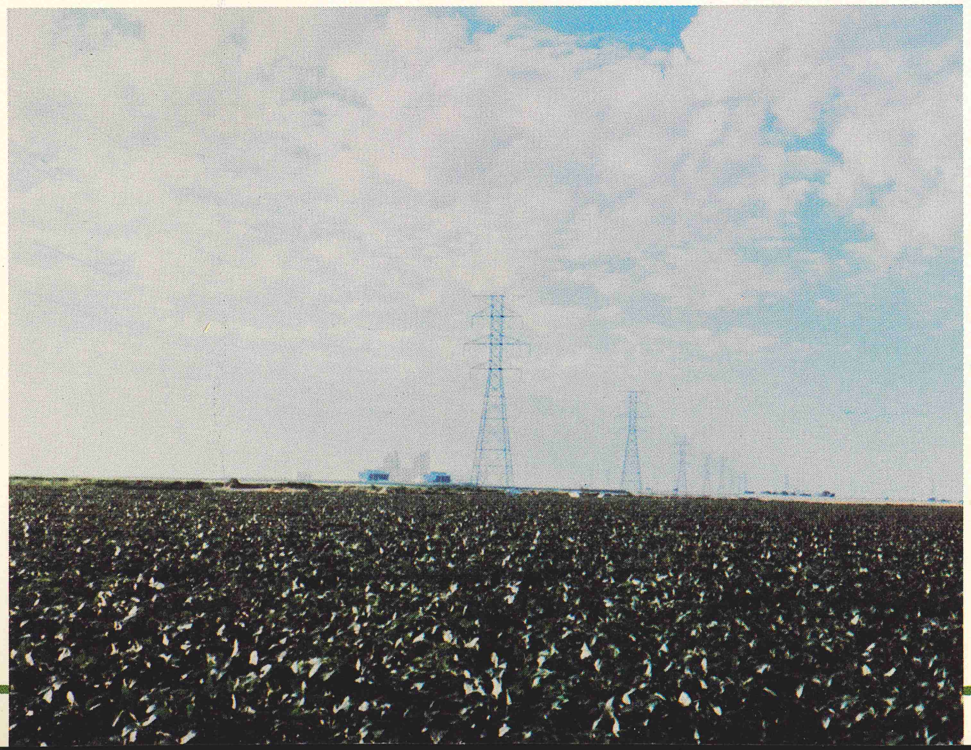
A strong in-house company, Southwestern serves a rapidly expanding service area. Peak growth is running six to seven percent a year. SPS is ready for the future now, employing innovation as it adds a major generating unit every two to three years.



*An SPS crew installs three of the nine O-B DynaVar arresters used to protect transformers at Clifford B. Jones Station, Lubbock, Texas.*



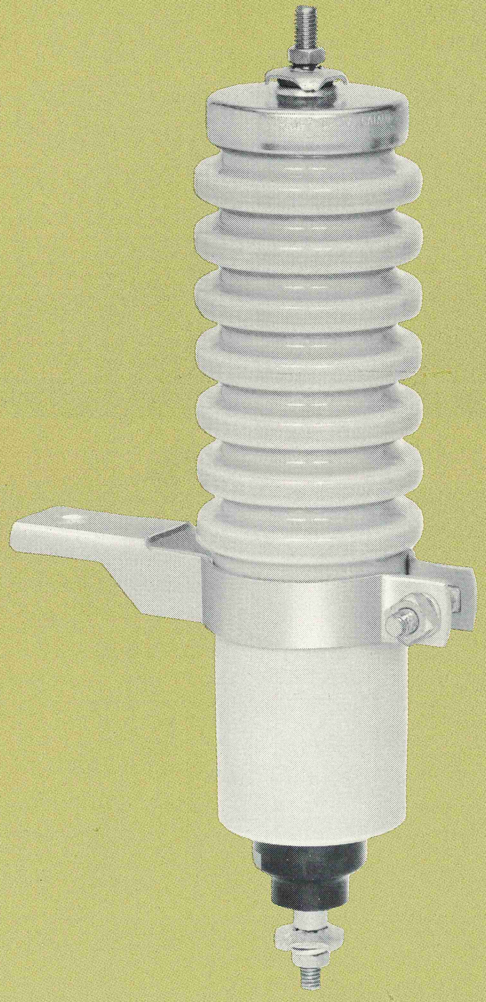
*Population of the area served by SPS numbers over a million people, but there's still plenty of room for growth!*

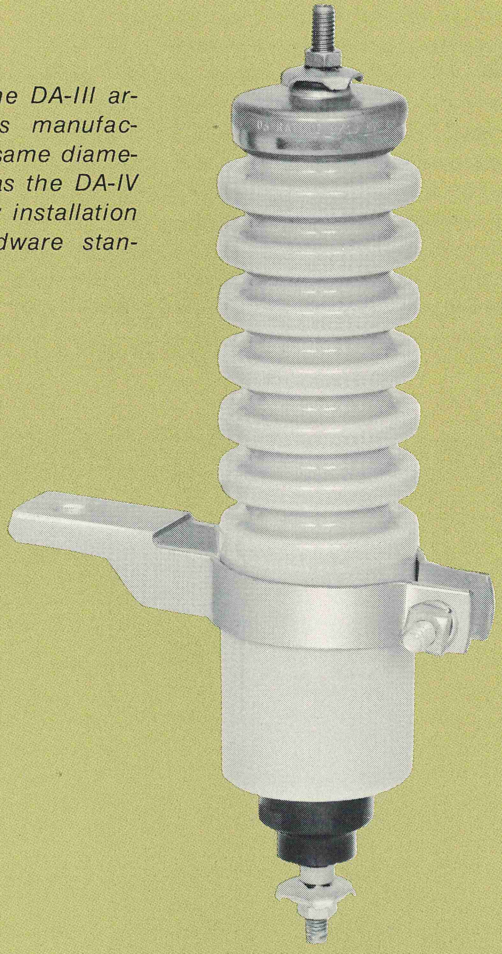


*Most transmission lines between Southwestern's power plants and major load centers are 230-kV lines.*

# DA modifications simplify installation

The DA-III can be distinguished from the DA-IV arrester by checking the nameplate data pressed in the rim of each arrester terminal cover.





*The barrel of the DA-III arrester (right) is manufactured with the same diameter and shape as the DA-IV (left) to simplify installation and allow hardware standardization.*

## Electrical characteristics remain the same

Ohio Brass now manufactures the barrel of the DA-III arrester with the same diameter and shape as the DA-IV. With the new design, attaching any of the DA arrester mounting brackets to the barrel of the DA-III or DA-IV is accomplished by merely slipping the barrel through the clamping band and tightening the nut on the clamping band bolt. The modification simplifies installation and allows O-B to offer the most commonly requested transformer mounting hardware as standard items, with common inventory.

At this point you may ask, "If the barrels are the same, how can I distinguish the DA-III from the DA-IV if I do not have both on hand for comparison? The answer is: Check the nameplate data pressed in the rim of each arrester terminal cover.

Ohio Brass has also simplified application of the ground wire connection on DA-III and DA-IV arresters by inverting the wire clamp and washer.

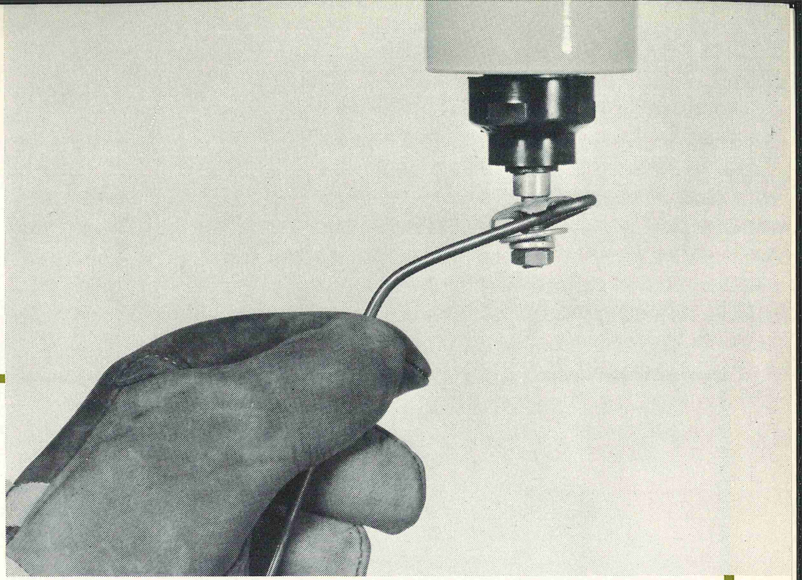
Making the conneciton is an easy lift, loop, tighten:

Lift: Using the looped end of the ground wire, separate the wire clamp from the flat washer.

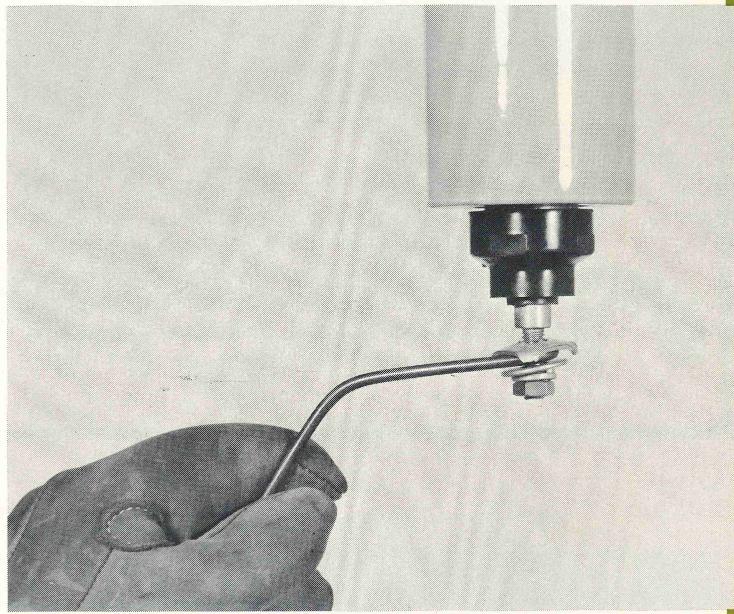
Loop: Slip the ground wire loop around the stud between the flat washer and the wire clamp.

Tighten: Snug the nut to complete the installation. A lockwasher is included with the assembly to keep the nut from loosening.

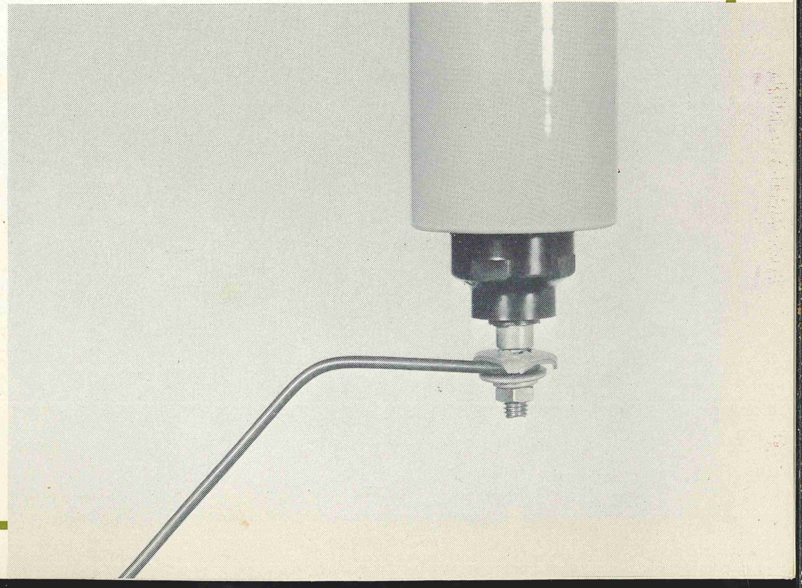
The DA-III barrel change and the ground terminal modification are part of a continuing program of product improvement.



*To make a distribution arrester ground wire connection, use the looped end of the ground wire to separate the wire clamp from the flat washer.*



*Next, slip the ground wire loop around the stud between the flat washer and the wire clamp.*



*Last, tighten the nut to complete the installation. A lockwasher is included with the assembly to keep the nut from loosening.*

# O-B introduces the Smog-3 insulator

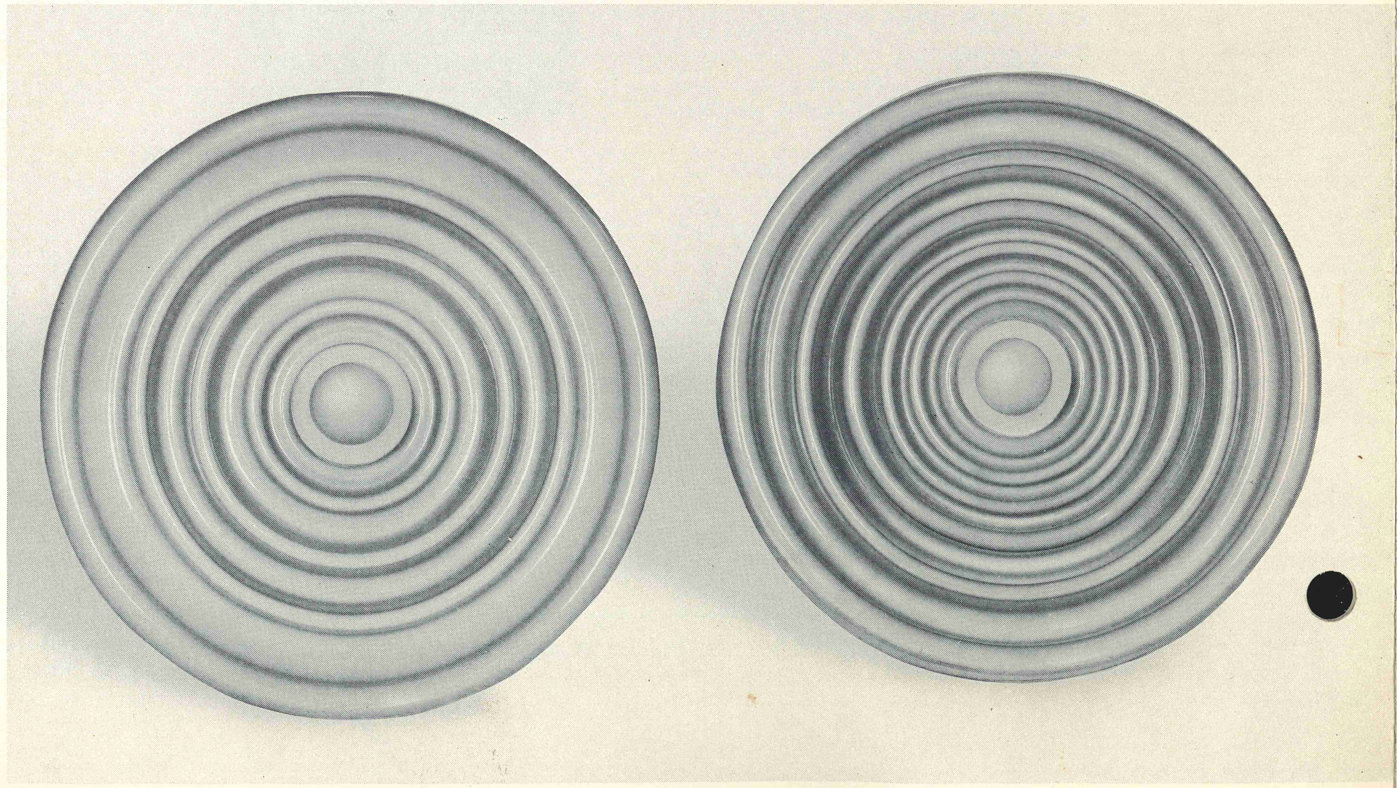
The Smog-3 offers an extended leakage distance of 18 inches for areas of severe contamination.

*The Smog-3 (right) achieves 18 inches of leakage distance by the insertion of one additional petticoat on the underside configuration and deeper grooves between petticoat flanges. A standard 10-inch unit appears on the left.*

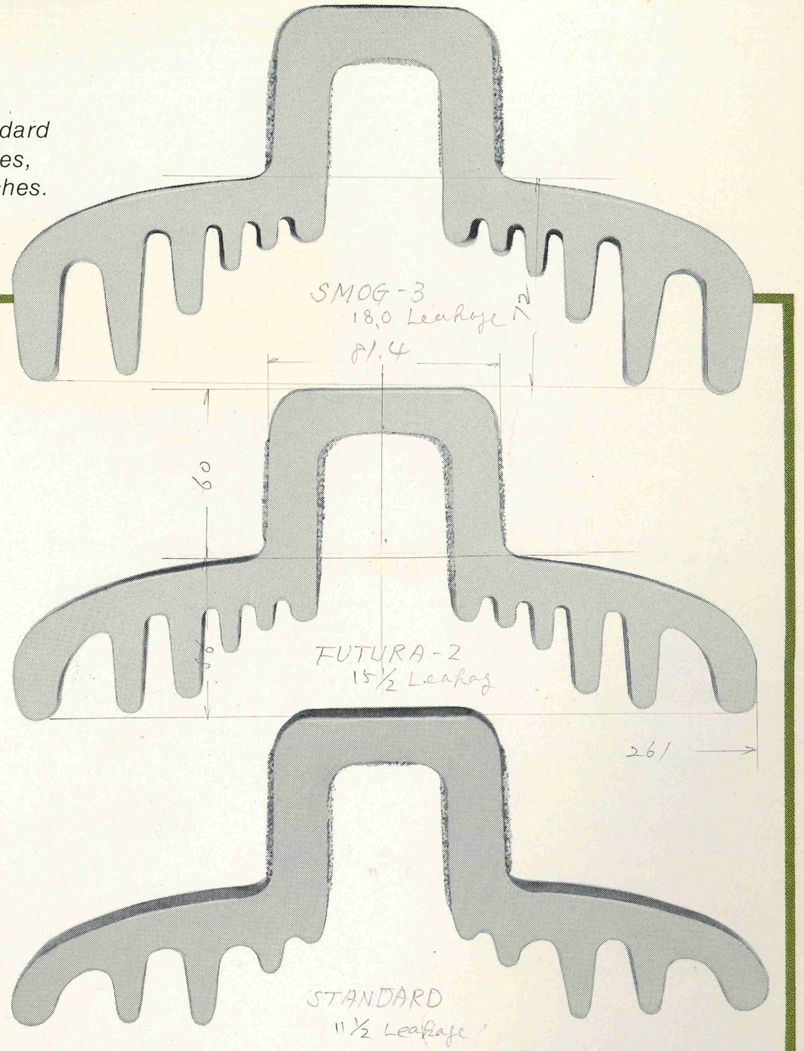
## Its greater leakage distance yields improved contamination performance

In areas where transmission lines are plagued by severe contamination problems, acceptable performance of the line may depend on obtaining the maximum number of inches of leakage. A new Ohio Brass insulator, the Smog-3, now offers the greatest leakage distance available in any O-B insulator – 18 inches. And this greater leakage distance has been achieved with only a minimum variation from standard insulator dimensions.

Smog-3 has been designed for areas where severe contamination demands extended leakage distance. Smog-3's 18 inches of leakage distance represent a 19 percent increase over the Futura-2 (15½ inches) and a 57 percent greater leakage distance than is available in O-B's standard 10-inch insulator.



*Illustrating the difference in leakage distance and disc contour between three models of O-B insulator. The standard 10-inch unit (bottom) has a leakage distance of 11½ inches, while the Futura-2 (middle) increased leakage to 15½ inches. Smog-3 (top) offers 18 inches of leakage distance.*




Yet Smog-3 uses the same ANSI hardware as O-B's standard insulator and retains the 5¾ inch section length. Smog-3 is also available with fittings conforming to International Electrotechnical Commission (IEC) standards.

Smog-3 can be ordered in either ball-socket or clevis models with 20 000-, 30 000- and 40 000-pound M&E ratings. Ball-socket models feature the CIS pin with the corrosion-intercepting sleeve. Catalog numbers and values are listed in the accompanying table.

Contamination performance of Smog-3 is superior to any other O-B insulator. Its higher withstand voltages allow a reduction in the number of units needed in contaminated areas, compared to strings of standard insulators, to get equal contamination performance or better.

Where contamination poses a serious problem, Smog-3 offers an improved solution. Ask your O-B district manager about the possible benefits of Smog-3 for your system.

### ELECTRICAL CHARACTERISTICS

| Catalog Number | | Flashover Voltage – kV | | | | Radio Influence Voltage | | Leakage Distance Inches | Low Frequency Puncture Voltage kV |
|---|---|---|---|---|---|---|---|---|---|
| | | Low Frequency | | Impulse Critical 1½ x 40 µs Wave | | Test Voltage to Ground | Max. RIV @ 1000 Hz | | |
| Ball-Socket Type | Clevis Type | Dry | Wet | Positive | Negative | Kilovolts | Microvolts | | |
| 47316 | 47317 | 95 | 50 | 150 | 160 | 10 | 50 | 18 | 130 |
| 47416 | 47417 | 95 | 50 | 150 | 160 | 10 | 50 | 18 | 130 |
| 47616 | 47617 | 85 | 50 | 130 | 135 | 10 | 50 | 18 | 115 |

### MECHANICAL CHARACTERISTICS

| Catalog Number | | Section Length Inches | | Porcelain Disc Diameter Inches | Combined M & E Strength Pounds | Recommended Maximum Sustained Load/lbs | Impact Strength Inch-Pounds | Pounds per 100 | | Number in Standard Package | Export Volume per 100 Cubic Feet |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ball-Socket Type | Clevis Type | B&S | CLEVIS | | | | | Net | Packed | | |
| 47316 | 47317 | 5¾ | 5¾ | 10.3 | 20 000 | 10 000 | 90 | 1430 | 1580 | 5 | 39 |
| 47416 | 47417 | 5¾ | 5¾ | 10.3 | 30 000 | 15 000 | 90 | 1570 | 1720 | 5 | 39 |
| 47616 | 47617 | 5¾ | 6½ | 10.5 | 40 000 | 20 000 | 90 | 1850 | 2000 | 5 | 39 |

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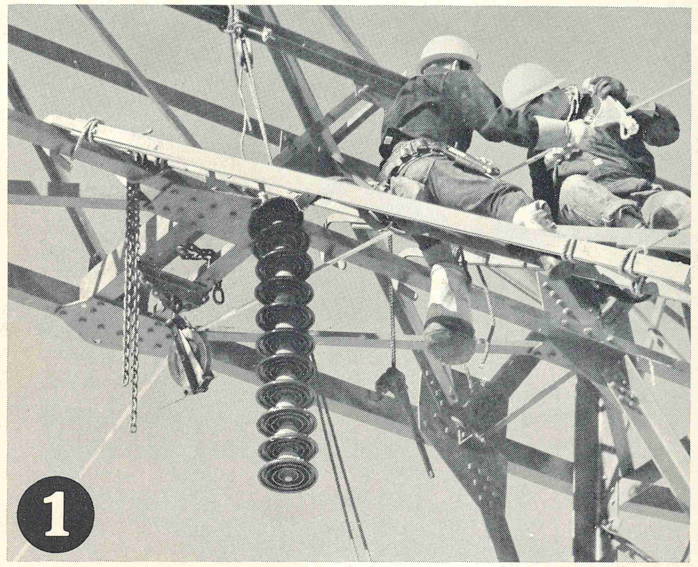
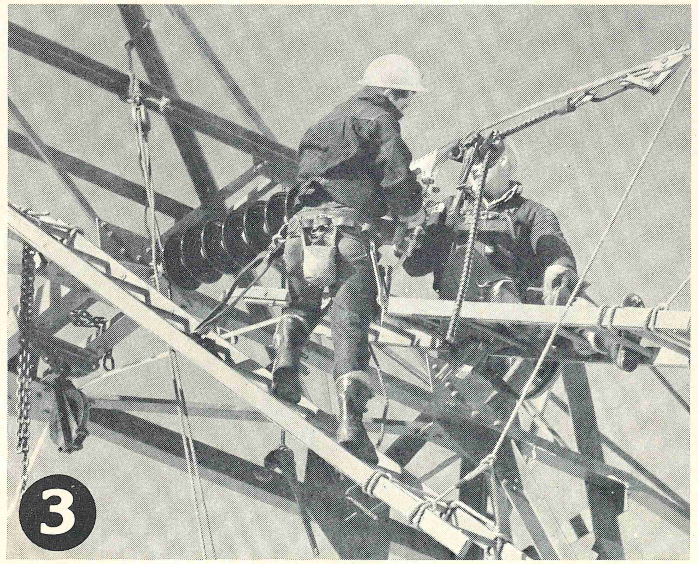
## Cooline strain clamps...simplify jumper-loop construction

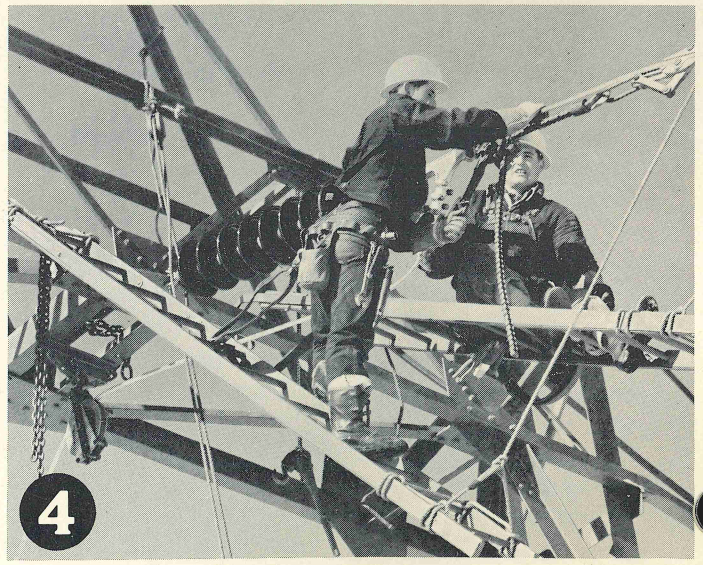



*Clamp is hung on conductor.*

*With insulators and clamp under tension, slack conductor is formed into clamp.*




*U-bolts are tightened onto conductor.*




*Tension is transferred to conductor when jack-hoist is removed.*

8002-H

# Hi-Tension News

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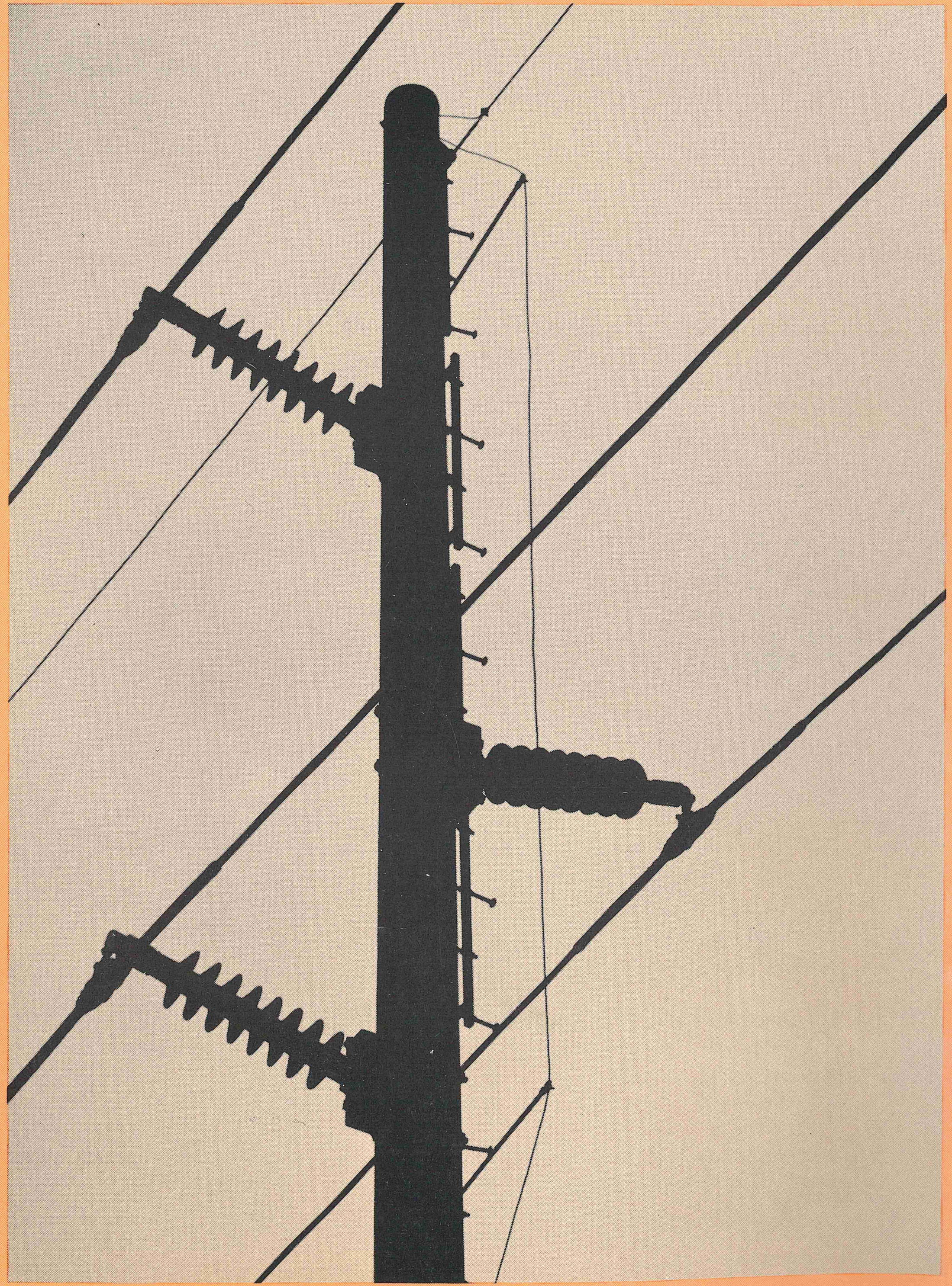
page 8

Need a great grip? Consider Cooline's advantages
page 10

### THE COVER PHOTO

The strength and resilience of Hi*Lite horizontal line post insulators offer new possibilities for alternative concepts in line construction



Hi*Lite
PROGRESS
REPORT NO. 4

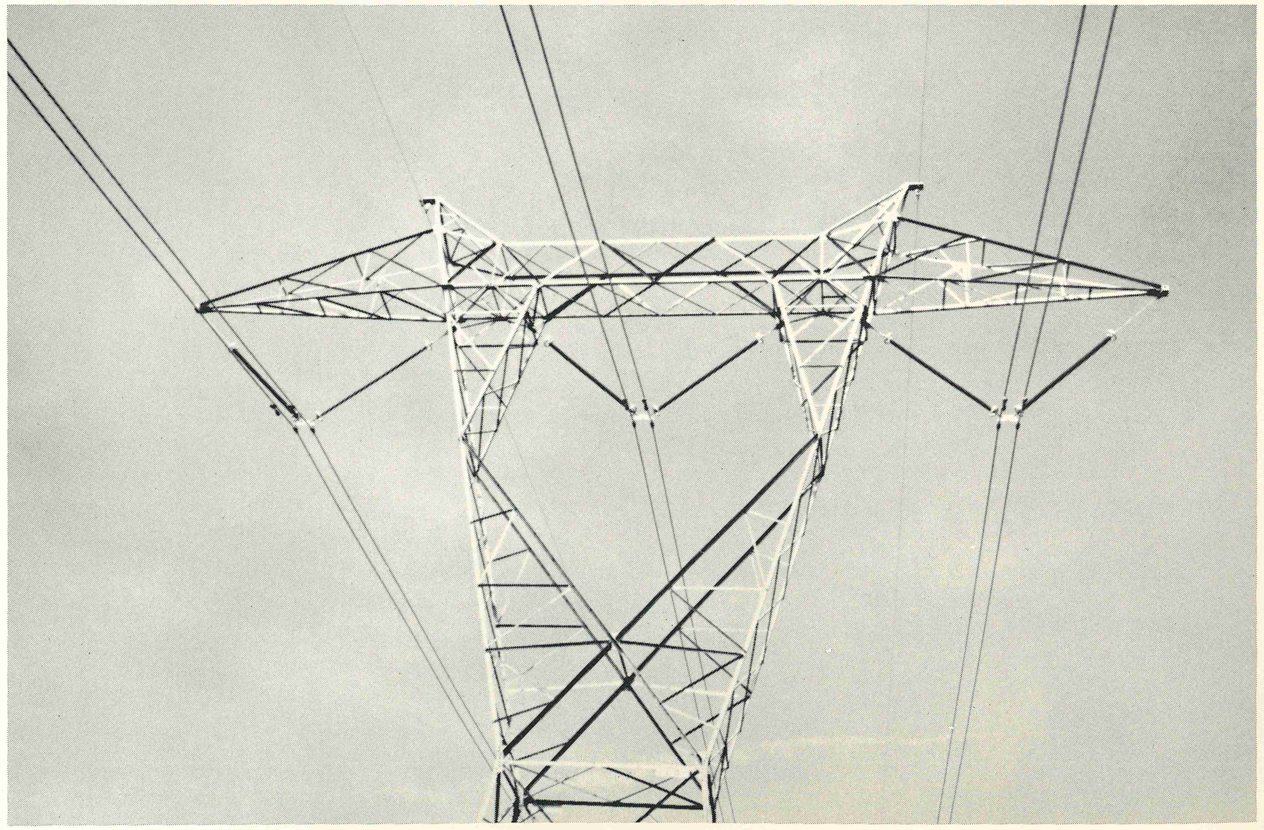
# Hi*Lite® gains wider acceptance as utilities seek new, economical solutions to transmission problems

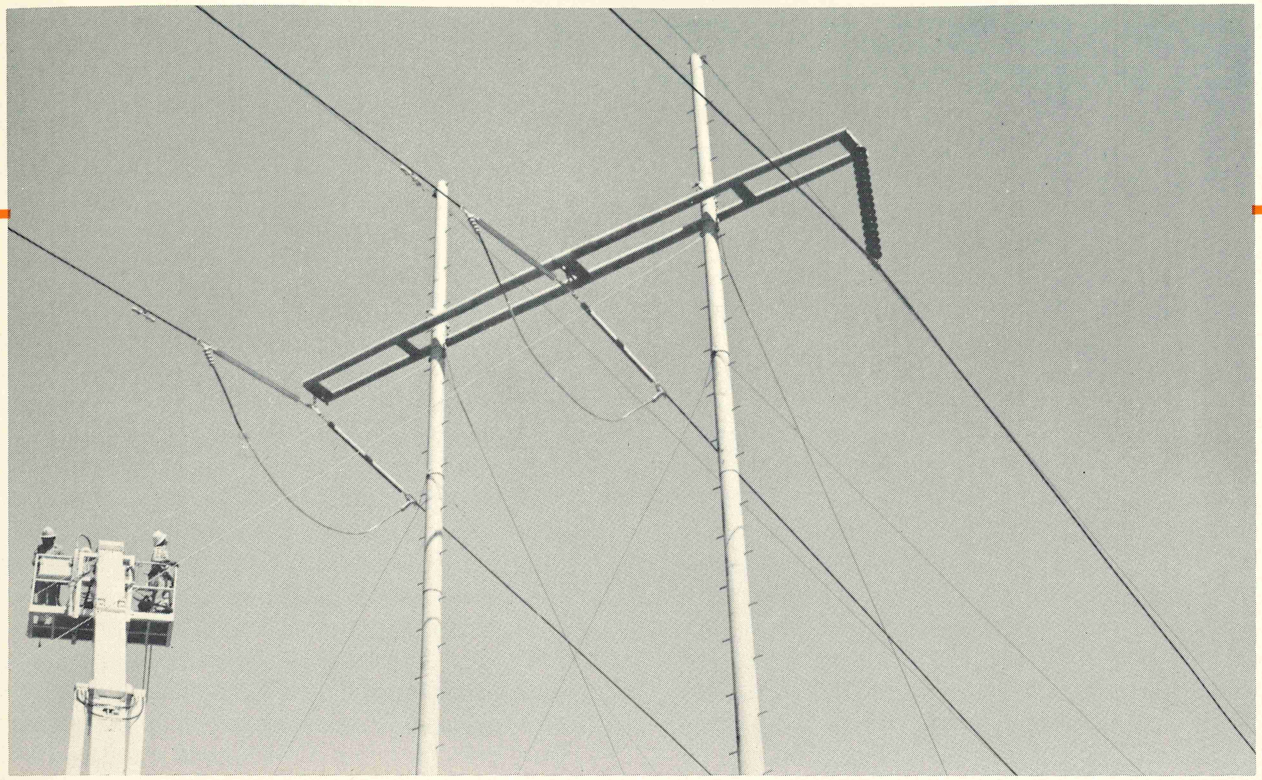
*Since its introduction four years ago, the Hi*Lite insulator has steadily gained acceptance among utilities and line designers as a reliable and economical tool for solving many transmission problems.*

Following Hi*Lite's introduction to the utility industry four years ago, it has been our practice periodically to report on recent application experience with Hi*Lite, including a frank discussion of any problems. As Hi*Lite is still a new product, we feel that prospective users deserve a regular appraisal of its service record.

We also believe that it is a record worth publishing, as Hi*Lite has demonstrated in four years of successful applications that it offers construction and maintenance benefits realized most clearly in service.

Hi*Lite's service experience has been extensive considering the relatively short time it has been available. Thousands of Hi*Lite insulators have gone into service. Installations have been made by most major U.S. utilities and by many cooperatives, municipals and governmental agencies. Applications range from 34.5 kV to 765 kV on operating systems, 11 kV to 50 kV on electrified railroads and up to 2255 kV in test projects.





*The light weight of Hi*Lites made upgrading feasible on a line where existing structures could not carry the weight of a heavier conductor. Conversion from tangent construction with porcelain to deadends using Hi*Lites allowed a higher current rating without reconductoring. By deadending both ends of a span, seven feet of midspan clearance was gained, enough to counteract the increased sag resulting from the higher operating temperature of the conductor. Linemen here have just finished converting the center phase to Hi*Lites.*

One of our early performance claims for Hi*Lite—its superior resistance to vandalism damage—has been borne out repeatedly in the field. In one instance, a utility had scheduled regular changeout of porcelain insulators every two weeks due to vandalism on a line parallel to a shooting range. Conversion to Hi*Lites on the 10 structures most subject to damage brought a dramatic change: No maintenance was required after a year's operation with Hi*Lites.

As utilities gain experience working with Hi*Lites, new applications demonstrate unique ways of exploiting Hi*Lite's advantages, both for service reliability and for cost effectiveness. In one case, upgrading a 230-kV line was seriously limited due to structure strength, eliminating the option of reconductoring. The utility chose to run the conductor at a higher current rating, allowing increased conductor temperature and sag. To counteract the sag, the utility elected to convert insulators on certain structures from tangent configurations using porcelain to deadends with two 20 000-pound Hi*Lite suspension units. As much as seven feet of midspan clearance was gained by deadending both ends of a span. By using Hi*Lites, weight savings per structure (three phases) amounted to more than 1100 pounds. Sufficient clearance was gained to permit a significant uprating without changing the conductor. This method could have wide application as older 230-kV and 345-kV lines, particularly those with wood structures, require uprating.

Two utilities found that the application of Hi*Lite insulators mounted on concrete poles provided an economical solution to the increasing problems and costs involved in securing new right-of-way. Pre-stressed concrete poles offer high strength and a slender appearance. Their strength permits an increase in spacing to lower line visibility and reduce right-of-way requirements. Hi*Lite insulators, particularly horizontal line posts, complement the advantages offered by concrete poles. The slender shape of Hi*Lite contributes to reduced line visibility. Hi*Lite's strength and durability give it a high reliability factor and its ease of handling significantly reduces construction labor and costs. For one utility, the application of Hi*Lites on concrete poles per-

*continued on next page*

mitted an attractive new line to be built almost totally on public right-of-way. In another instance, upgrading from 69 kV to 138 kV using a heavier conductor was achieved with Hi*Lites on concrete poles while adhering to existing span distances, thereby avoiding the need to negotiate new easements.

During the last year, there has been growing interest in using Hi*Lite suspension insulators as jumper supports, thus eliminating many lightly loaded joints with an attendant reduction in RIV and TVI. In EHV construction, a post-type insulator can support the jumper to eliminate weighted strings of porcelain insulators. The post-type jumper support can be mounted to the underside of the tower arm, or to the face of the structure, much as a normal horizontal line post. In either case, there is sufficient stiffness to position the jumper loop and hold it in place. A simple spacer has been developed for this Hi*Lite application to retain the configuration of the conductor bundle and provide adequate shielding for the insulator without additional rings.

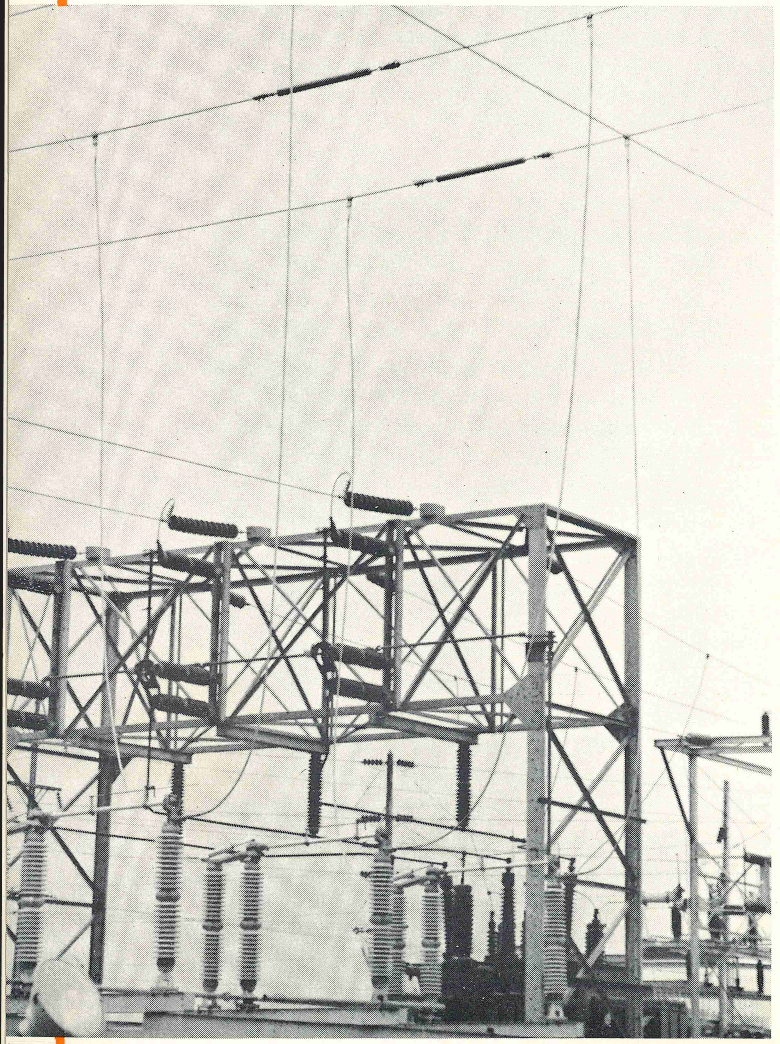
The advantages Hi*Lite offers in horizontal-V construction are just beginning to be realized by line designers. Hi*Lite's light weight, single-piece construction, flexibility and resistance to damage during construction would seem to make it the natural insulator for this type of application. Because of the insulator's ability to absorb shock without damage, the supporting and connecting hardware can be reduced in complexity without introducing construction risk.

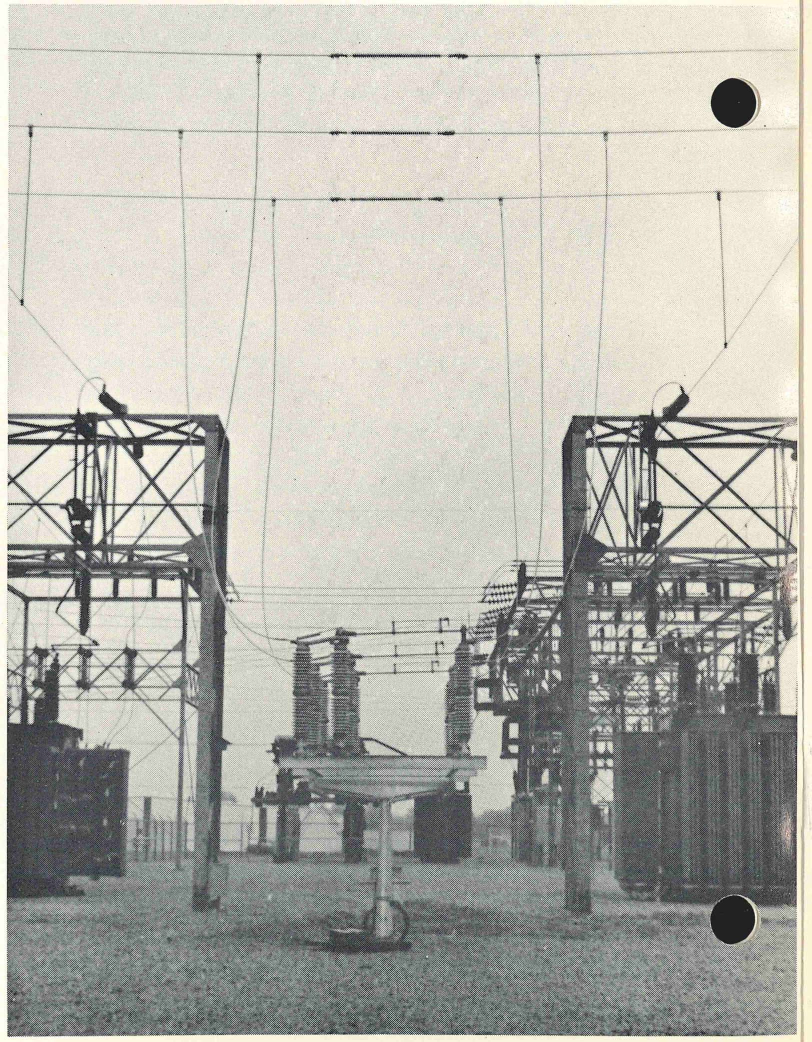
Hi*Lite has begun to receive considerable attention for substation application. As a bus support insulator, Hi*Lite has extremely high cantilever strength – higher than now available with porcelain – and it offers improved resistance to impact damage and emergency mechanical loadings. The light weight of Hi*Lite permits its use as a bus spacer. For older stations facing redesign as fault currents increase, this application provides one solution to the limitation in cantilever strength often found in existing bus supports. Individual phases can be electrically isolated but mechanically coupled, so that bus supports on unfaulted phases can share in mechanical loading under fault conditions.

One construction problem encountered within the last year involved a Hi*Lite unit in deadend position with a turnbuckle behind it. In tightening the turnbuckle against full line tension, the construction crew succeeded in twisting the insulator instead of the turnbuckle. The insulator finally broke in a torsion failure; the total number of turns is unknown. The utility involved placed no blame on the insulator, though a need was recognized for altering construction standards.

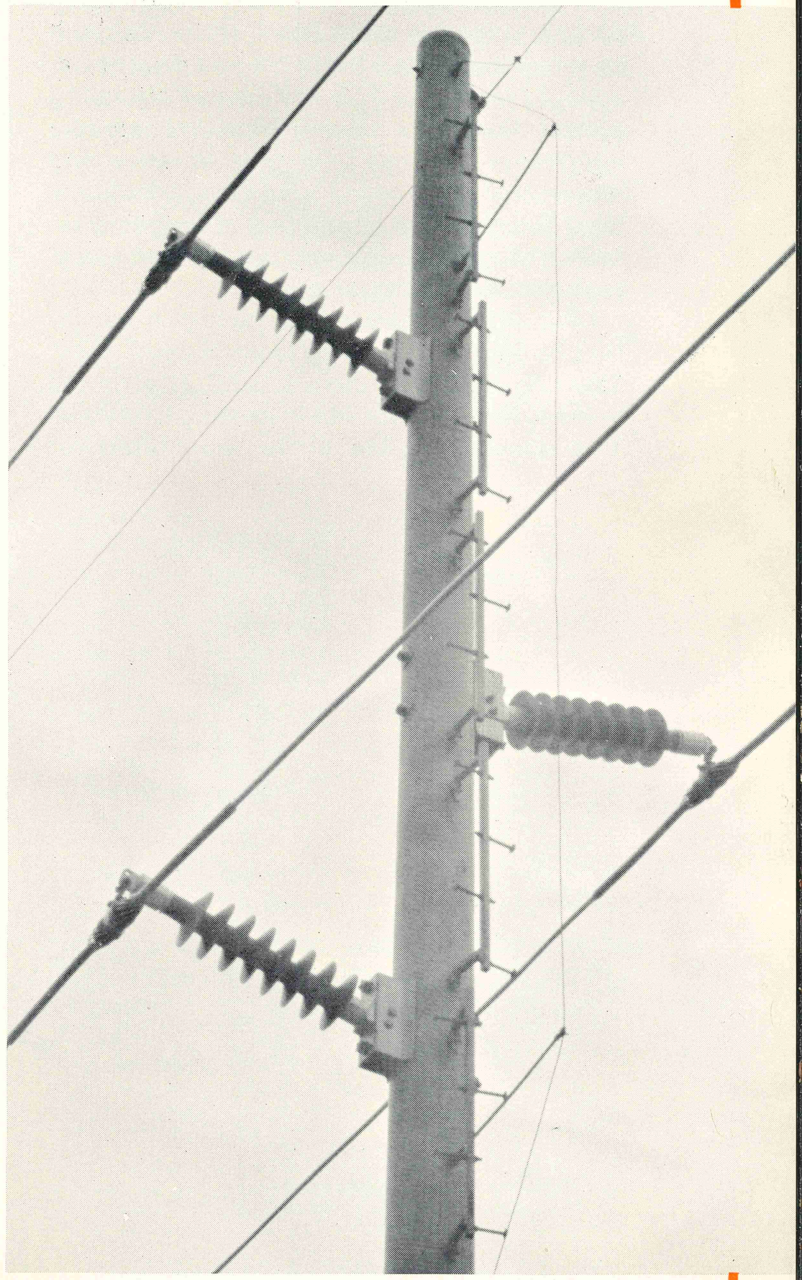
Another minor problem, associated with corona, has been reported from a UHV test project operating between 1100 kV and 1500 kV. Inadequate shielding at one deadend was deemed responsible for minor damage to one unit, while adequately shielded Hi*Lites in V-string tangent positions elsewhere on the line have experienced no problems. Two other

*continued on next page*





*Use of Hi*Lite suspension units as an integral part of a 138-kV strain bus simplifies station layout by eliminating supporting structures. The Hi*Lites impose no weight problems and save both space and additional structure cost.*



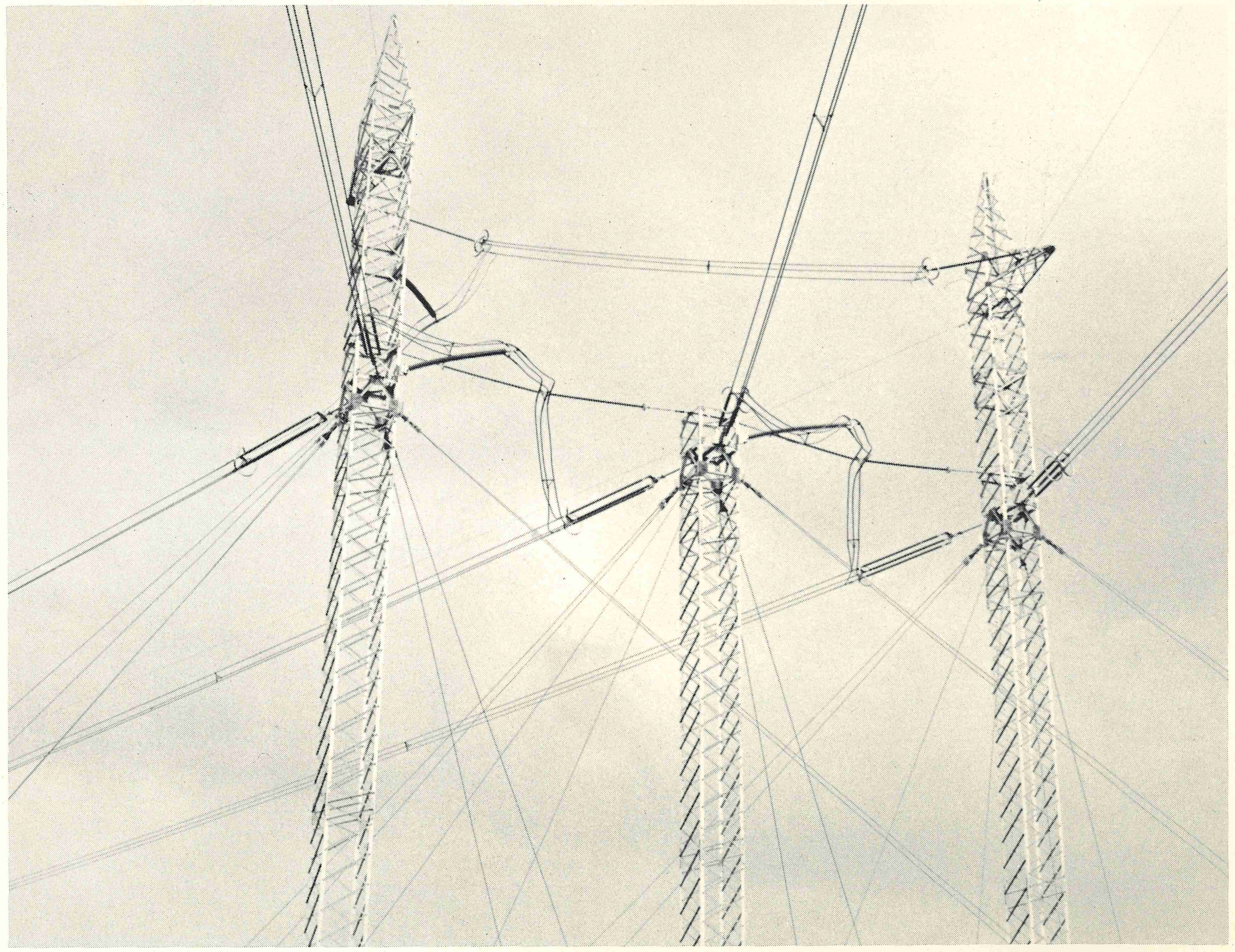
*The application of Hi*Lites mounted on concrete poles provides one solution to the problem of obtaining sufficient right-of-way in congested areas. The high strength of prestressed concrete poles permits an increase in spacing to lower line visibility and reduce right-of-way requirements. The strength and slender appearance of Hi*Lites complement the advantages of concrete poles while offering high electrical and mechanical reliability and lower construction cost.*

## Hi*Lite progress report (continued)

UHV projects using Hi*Lites have reported no corona problems whatsoever. While it should be remembered that these are test projects, at voltages far higher than any present operating system, they have already provided valuable information that has been used to refine ring requirements for lower voltage applications. Ohio Brass is also continuing an ongoing research program to study corona phenomena at high and low voltages.

Ohio Brass recommends control rings for Hi*Lite applications at voltages above 230 kV. The ring design is simple, with attachment made to the insulator, not to existing hardware. This allows Hi*Lites to be substituted for porcelain insulators on older lines or conversion projects without altering hardware to accommodate rings. The rings are relatively small and easy to attach to insulators presently in service. Aluminum foil labels indicating the correct ring position are attached to ground-end control rings and to the line end of Hi*Lite units specified for applications at 345 kV and above.

Hi*Lite's solid performance record is our best indicator of what the future holds for this product. As utilities gain more field experience with the insulator, we expect Hi*Lite's unique advantages to continue to be put to work in new ways.



*There has been increased interest in Hi*Lite horizontal post units as jumper supports. The Hi*Lite post has sufficient stiffness to position the jumper loop and hold it in place. Hi*Lites are also used in other novel ways on this 500-kV transposition structure.*



## DA-III, DA-IV and DynaVar arresters added to list of Ohio Brass products approved for use on REA electrification systems

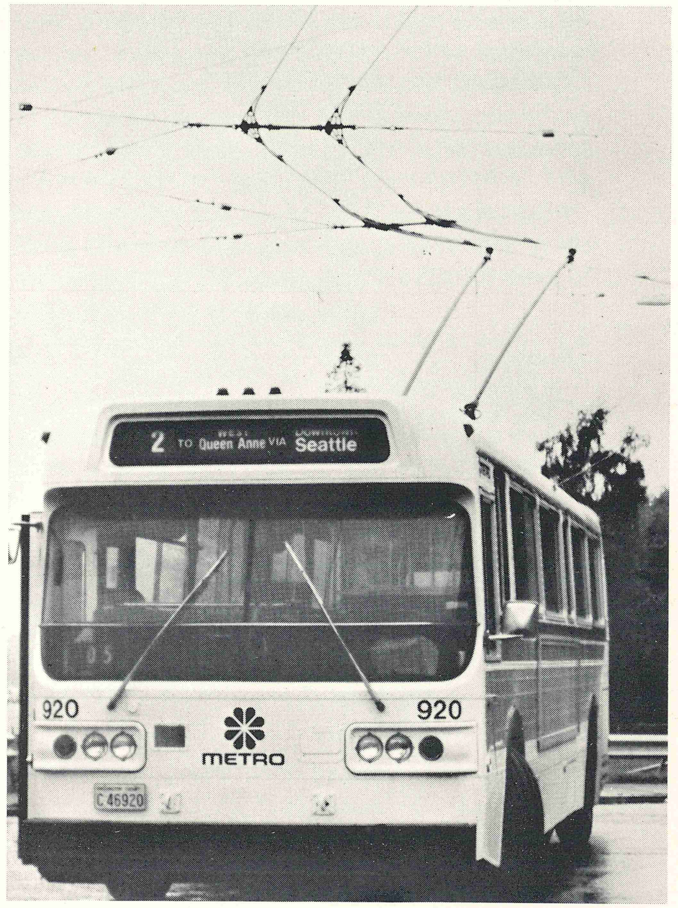
| REA Description | Approved List Ohio Brass No. | Page |
|---|---|---|
| Insulator, pintype | 12847*<br>38148*<br>38149* | a-1 |
| Insulator, pintype | 38246-7010*<br>38223-7010*<br>38255-7010* | a-2 |
| Insulator, suspension | 32433<br>42399<br>48008*<br>48019* | k-1 |
| Insulator, suspension | 32440<br>47415<br>47410<br>32439 | k-2 |
| Clamp, deadend | 78500<br>80442<br>80500<br>81500<br>86534<br>88500<br>89237 | l-1 |
| Clamp, deadend | 80437 | l-2 |
| Clamp, suspension | 83044<br>83064<br>83074<br>83084<br>83104 | m-1 |
| Clamp, suspension | 82860<br>83044 | m-2 |
| Insulator, guy strain | 31502*<br>31504*<br>31506*<br>31352* | w |
| Surge arresters, distribution (valve type) | DA-III: 9/10, 18 kV (Normal duty)<br>DA-IV: 9, 10, 18 kV (Heavy duty) | ae-1 |
| Surge arresters, substation use | GP: 3-72 kV (Intermediate)<br>MPA: 3-15 kV (Station)<br>MP: 3-48 kV (Station)<br>MPR: 60-312 kV (Station)<br>DA (Valve): 3, 9, 10, 18 kV (Distribution) | ae-2 |
| Shackle, anchor | 13722 | bo |
| End link | 79272 | br |
| Clevis, thimble, side opening | 82825 | ci |

*Std. Glaze-Gray USAS C70 (Skytone)

| REA Description | Approved List Ohio Brass No. | Page |
|---|---|---|
| Insulator, post type | 43400-7040*<br>43400-7010*<br>43401-7040*<br>43401-7010*<br>37620-7040*<br>37620-7010*<br>41640-7040*<br>41640-7010*<br>41650-7040*<br>41650-7010* | ea |
| Bracket, poletop for post type insulators | 89725<br>84324 | eb |
| Hook, ball | 78420 | eh |
| Clamps, suspension with socket eye | 83085<br>83105<br>83115<br>83125<br>83145<br>87085<br>87105<br>87115<br>87135 | ei |
| Clamps, deadend with socket eye | 80440<br>80445<br>80450<br>86536<br>86540<br>86546 | ej |
| Surge arresters for under-ground system pole risers | DA-III: 9/10, 18 kV (Distribution, Normal duty)<br>DA-IV: 9, 10, 18 kV (Distribution, Heavy duty) | Uae |
| | GP-9 A or B (Intermediate)<br>GP-10 A or B (Intermediate)<br>GP-18 A or B (Intermediate) | |

| REA Description | Conditional List Ohio Brass No. | Page |
|---|---|---|
| Insulator, post type | 43740*<br>43790*<br>47043 | ea |
| Surge arresters, metal-oxide type | DynaVar: 52-312 kV (Station) | ae |

# Seattle becomes nation's showcase for electric trolley




Ohio Brass is supplying trolley shoes, trolley poles and trolley overhead equipment for rehabilitation and expansion of Metro's trolley system.

## Rehabilitated system harmonizes with modern city

Citizens of the Municipality of Metropolitan Seattle like electric trolley coaches. When age and obsolescence began to take their toll of a tired pre-World War II system, citizens gave hearty support to expansion and rehabilitation of that system. New trolley coaches and upgrading of the power system are part of a voter-approved comprehensive plan for public transportation, also known as the 1980 plan, adopted in 1972 by the Municipality of Metropolitan Seattle.

The Metro Council is a 37-member governing body of elected and appointed officials that includes members of the Seattle City Council and King County Council and representatives of governing bodies in surrounding areas.

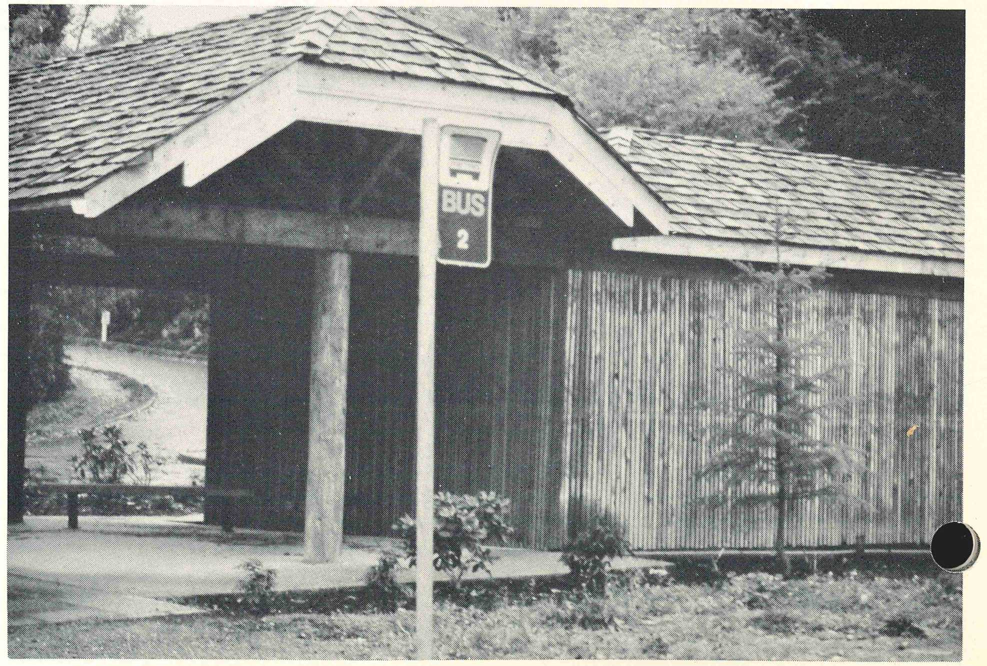
Modernization and expansion of the electric trolley system serving Seattle is a $46.2-million project, 80 percent funded by the federal Urban Mass Transportation Administration, with Metro and the city of Seattle sharing the local cost. All the old trolley overhead wires and switches are being replaced by new equipment. Twenty-six new neighborhood d-c power stations will replace the old centralized system of five stations. Spaced at intervals along each trolley coach route, they will eliminate the need for the thick, unsightly black power feeder cables associated with old trolley systems. By the time the program is completed in 1981, length of the system will be expanded from 28 to 52 miles of electrified routes.

The entire trolley system was shut down temporarily in January 1978 so construction could proceed efficiently and safely. Diesel buses substituted along trolley coach routes. Newly rehabilitated Routes 2 and 10 were back in service by September 1979.

Metro's 59 old trolley coaches have been retired and replaced by 109 new AM General trolley coaches equipped with "chopper" electronic acceleration controls to provide smooth stops and starts. Powerful electric trolley coaches are much quieter than diesel coaches on many of Seattle's steep neighborhood streets. They help reduce air pollution. Another important factor is fuel availability. Since electric power is available from a variety of sources, trolley coach service will be less affected by shortages of petroleum fuel than diesel service.

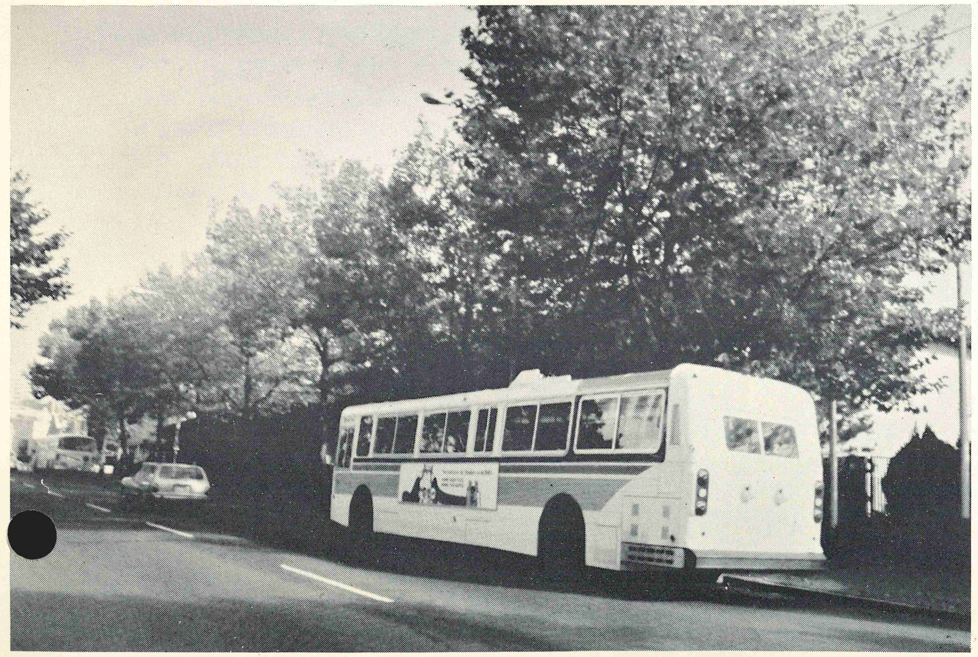
With more cities changing from diesel to electic transit vehicles, and with no sign of a change in the trend of increasing problems with petroleum supplies, the potential market for trolley service is greater than ever before. Seattle's rehabilitated and expanded system serves as a showcase for the nation.

Madrona substation, one of Seattle's new neighborhood d-c power stations, also serves as a bus shelter/stop.



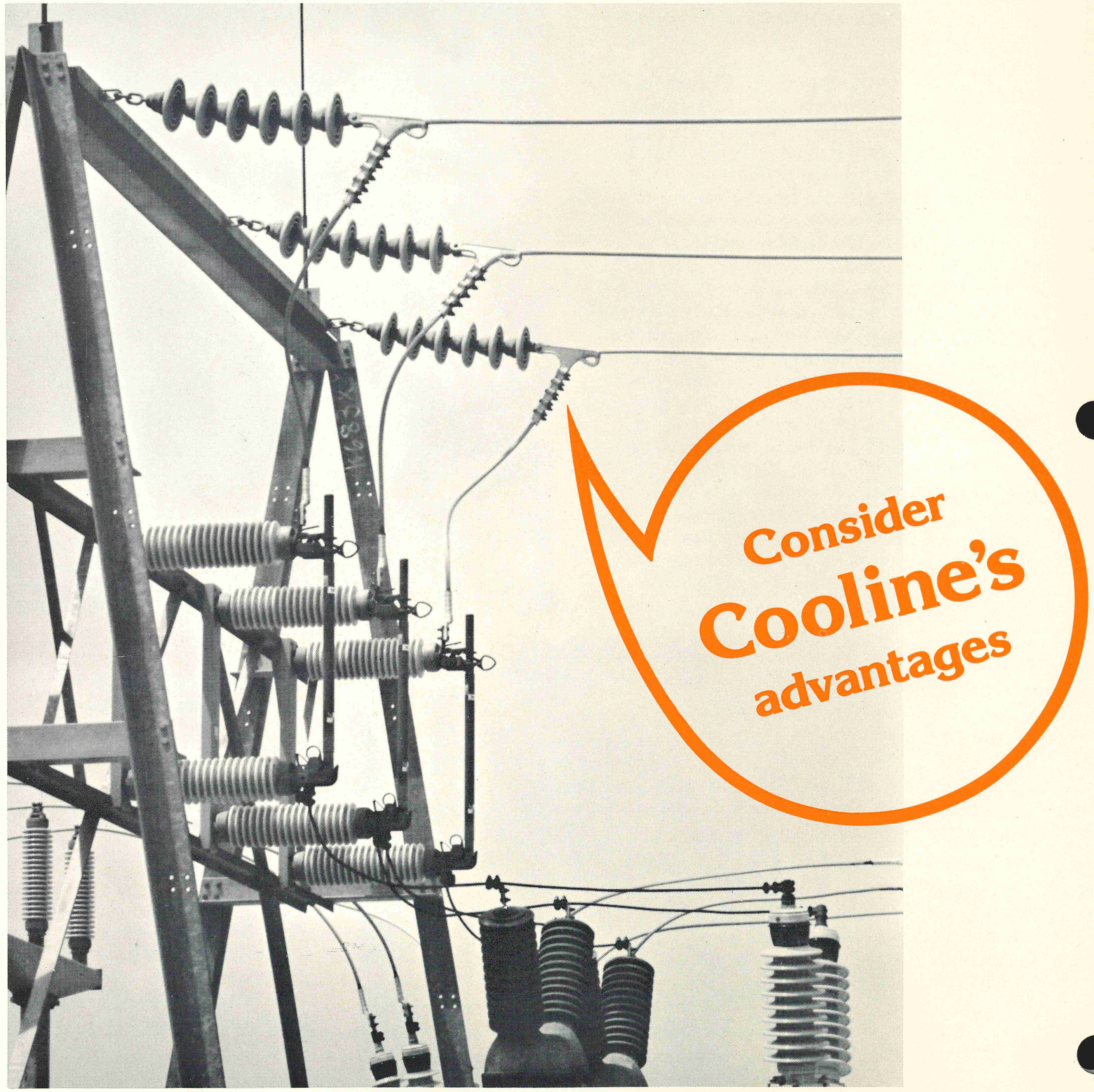
A rehabilitated trolley system harmonizes with modern downtown Seattle.

Metro's 109 new AM General trolley coaches are equipped with "chopper" electronic acceleration controls to provide smooth stops and starts.



Trolley wires on Seattle's rehabilitated trolley system are practically invisible. Most of the thick, unsightly black power feeder cables are located underground.

# Need a great grip?




*By combining mechanical strength with electrical integrity, the aluminum Cooline strain clamp offers excellent support for an aluminum conductor in deadend application.*



In deadend applications, the fundamental requirement of a strain clamp is to combine adequate mechanical strength with compatibility to the conductor it supports. Ohio Brass has 30 years' experience producing a nonmagnetic aluminum clamp, the Cooline, that meets this service criterion and more.

Cooline strain clamps are recommended for use with all-aluminum and ACSR conductors, providing excellent support for conductors ranging in sizes between 0.20 and 1.823 inches in diameter. Cooline is a quadrant clamp especially designed for high-voltage applications. Its waved clamping seat can deliver holding strengths of over 90 percent of the conductor strength without strand damage.

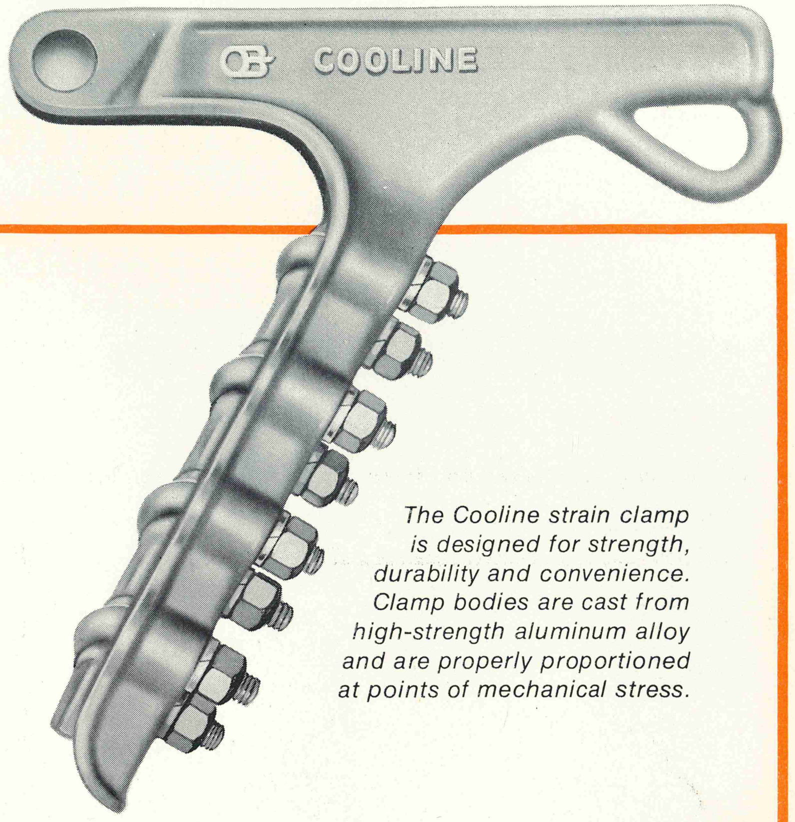
Cooline clamp bodies are cast from high-strength, heat-treated aluminum alloy using a permanent mold process. Steel U-bolts, clevis pins and associated components found on Cooline clamps are hot-dip galvanized for prolonged service life. Cooline clamps use stainless steel cotter pins.

But Cooline's design offers advantages beyond strength and durability. Covenience is another consideration, both during installation and in service. Cooline's U-bolts have high clamping power. Their length facilitates hot-line work. The U-bolts draw down easily with no danger of stripping threads.

Cooline strain clamps can be installed quickly and easily with a hand wrench. Construction of continuous jumper loops is simplified because Cooline clamps can be installed without cutting the conductor – a practice that eliminates full current-carrying splices in slack cable. Deadend adjustment requires no specialized installation tools. At any future time, the full holding power of the clamp can be inspected merely by checking the tightness of the bolts with a hand wrench or by hot stick.

Cooline's many advantages add up to one great grip. For more information on the aluminum Cooline strain clamp, see O-B Catalog 61.

*continued on next page*




*The Cooline strain clamp is designed for strength, durability and convenience. Clamp bodies are cast from high-strength aluminum alloy and are properly proportioned at points of mechanical stress.*

| Catalog Number (No Fitting) | Conductor Diameter Min. Inches | Conductor Diameter Max. Inches | U-bolts No. | U-bolts Size Inches | Ultimate Strength Pounds |
|---|---|---|---|---|---|
| 86537 | 0.20 | 0.59 | 3 | ½ | 15 000 |
| 86542 | 0.30 | 0.72 | 4 | ½ | 20 000 |
| 86548 | 0.48 | 0.86 | 4 | 9/16 | 23 000 |
| 86552 | 0.50 | 1.03 | 5 | 9/16 | 27 000 |
| 86557 | 0.71 | 1.20 | 5 | ⅝ | 30 000 |
| 86562 | 0.90 | 1.40 | 5 | ⅝ | 35 000 |
| 87767 | 1.18 | 1.55 | 5 | ⅝ | 35 000 |
| 92234 | 1.125 | 1.823 | 5 | ⅝ | 50 000 |

Eight clamp sizes cover the range of conductors between 0.20 and 1.823 inches in diameter.
Refer to page 8 of O-B Catalog 61 for complete listings.